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CARDIOPULMONARY RESUSCITATION SKILL RETENTION OVER TIME

by

© Deborah S. Poeter

A Thesis

Submitted to the Faculty of Graduate Studies and Research

In Partial Fulfillment of the Requirement for the Degree

of Master of Education

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Date June 16, 1983

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ABSTRACT

The problem of this study was to examine the extent to which people retain CPR skills over time. Students at the University of Alberta Hospitals School of Nursing were randomly selected from four classes which had been certified in CPR six, ten, twelve or eighteen months previously and were retested on a recording Resusi-Anne manniken.

Skill retention was analyzed in terms of overall skill retention, retention of the continuous and discrete aspects of the skill of CPR and whether practice since initial certification enhanced skill retention.

The results of the analysis indicated that: no student in any group performed both one and two man CPR according to Canadian Heart Foundation standards; only one student (certified ten months previously) performed one man CPR according to Canadian Heart Foundation standards; only one student (certified twelve months ago) performed two man CPR according to Canadian Heart Foundation standards; discrete skills were generally performed poorly; continuous skills were performed better than discrete skills; and students who had practiced CPR since initial certification did not perform according to Canadian Heart Foundation standards.

The conclusion reached following this study was that CPR recertification should be carried out at least every six months after initial certification to ensure that the skill is being performed at or above Canadian Heart Foundation standards.

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CHAPTER I

Introduction

Each year more than 650,000 people die from cardiovascular diseases in the United States. Of these, approximately 350,000 die outside of hospital (Shapter, 1976:4). Many die within minutes of the onset of symptoms, often in the company of friends, colleagues or bystanders. If proper resuscitative techniques were applied promptly to these individuals, many lives may be saved.

The discovery, in 1960, of cardiopulmonary resuscitation was a major breakthrough in medical science. This technique to restore breathing and circulation to a stricken victim can be applied immediately by a trained person (Barick, 1972:62). Much of its merit lies in the fact that cardiopulmonary resuscitation requires no special equipment and can be learned by any reasonably intelligent individual regardless of prior education or background (Shapter, 1976:4). Thus, the certification of more people in the techniques of cardiopulmonary resuscitation in accordance with the standards set out by the Canadian Heart Foundation is desirable. It is also of paramount importance that the people certified in cardiopulmonary resuscitation remain skilled and current.

Information about retention levels over given time periods to determine long-term competency of persons trained to apply cardiopulmonary resuscitation in emergencies is, for all practical purposes, non-existent (Barick, 1977:62). Consequently, retraining or

recertification practices to ensure currency and accuracy of cardiopulmonary resuscitation techniques are at best ad hoc. The Canadian Heart Foundation recommends that non-medical groups receive recertification one year from the initial course and then at least every three years thereafter or more frequently where indicated. This seems to be a very general statement with no known research to support it.

Therefore, a study to examine the skill retention of cardiopulmonary resuscitation over time to help guide recertification practices seems necessary. Educational administrators involved in the decision making regarding recertification practices would then have a base from which to make informed decisions regarding the timing of CPR recertification.

Research Problem

The purpose of this study is to examine the extent to which people retain CPR skills over time. In order to obtain data, this study will examine the retention of one and two man cardiopulmonary resuscitation over varying periods in order to determine if and when it is necessary to reteach or recertify.

Subproblems

1. At what point in time does the skill level of CPR fall below Canadian Heart Foundation standards?
2. Has the skill of CPR been practiced since initial certification?
3. Does this practice have any effect on skill retention?
4. Has the skill of CPR been utilized during an emergency?
5. Does this use have any effect on skill retention?

6. To what extent are the continuous and discrete aspects of CPR retained over periods of time?

Importance of Study

The study is valuable as it contributes to the limited amount of research which has been done on the retention of cardiopulmonary resuscitation skills. Specifically, the study is of value because it is necessary to know how long cardiopulonary resuscitation skills are retained at criterion levels.

The study is also important as it deals specifically with the issue of recertification. In Alberta, at the present time, recertification in basic cardiopulmonary resuscitation is not required. It is the belief of many people actively involved in cardiopulmonary resuscitation in Alberta that recertification is necessary. What is not known, however, is the time period after which this recertification is necessary.

This study is important to educational administrators as these are the persons who make decisions concerning CPR programs. In order to make informed decisions regarding CPR recertification, it is necessary for them to know how long CPR skills are retained at Canadian Heart Foundation criterion levels so that they can administer recertification programs.

Definition of Terms

Artificial ventilation - consists of mouth-to-mouth or mouth-to-nose breathing which sustains life by breathing the unused oxygen in the rescuer's lungs into the lungs of a victim who has stopped breathing.

Basic life support - is an emergency first aid procedure that consists of recognizing respiratory and cardiac arrest and starting the proper application of cardiopulmonary resuscitation to maintain life.

Cardiac arrest - sudden cessation of the heart's pumping action.

Cardiopulmonary resuscitation (CPR) - is a basic, life-saving procedure whose purpose is to restore life after sudden and unexpected death. It consists of establishing and maintaining an open airway, providing artificial ventilation by means of rescue breathing, and providing artificial circulation by means of external cardiac compression.

Certification - process whereby a person passes written and practical examinations in accordance with uniform standards set out by the Canadian Heart Foundation following a course in basic cardiopulmonary resuscitation and is said to be certified. At the time of the examinations he is qualified to carry out CPR techniques.

Distributed practice - practice which is spread out over a period of time. (Garry and Kingsley, 1970:209-210).

External cardiac compression - produces circulation by pressing down on the chest, thus squeezing the heart to pump blood through it and out to the body. It is never performed without rescue breathing.

Learning - permanent change in behavior brought about through practice. Retention over time is usually the test of whether learning has occurred during practice (Marteniuk, 1979:197).

Massed practice - practice which is concentrated in long, unbroken periods. (Garry and Kingsley, 1970:209-210).

Mental practice - symbolic rehearsal of a physical activity in the absence of any gross muscular movements.

Motor learning - learning that is evidenced through muscular responses that are generally expressed in the movement of one's body or a body part.

Motor skill - is a highly specific motor response that is developed to produce a specific result.

Overlearning - continued practice of a skill after attaining a criterion level of performance irrespective of whether proficiency increases or not.

Performance - level of skill acquisition.

Recertification - process whereby a person passes a practical examination after a specified period of time in accordance with uniform standards set out by the Canadian Heart Foundation and is said to be recertified.

Retention - refers to the persistence of knowledge or skills which have been learned following periods without practice.

Skill - a particular, more or less complex activity which requires a period of deliberate training and practice to be performed and which often has some recognized useful function.

Assumptions, Delimitations, and Limitations

Assumptions

The basic assumption for this study is that skill retention of cardiopulmonary resuscitation does change over a period of time. It is also assumed that recertification is the process which will be

effective in increasing cardiopulmonary resuscitation skill levels to those specified by the Canadian Heart Foundation.

Delimitations

The study will be delimited to the nursing students certified in basic cardiopulmonary resuscitation at the University of Alberta Hospitals School of Nursing at the time of the study (December, 1982).

This study will be delimited to the criteria as specified by the Canadian Heart Foundation as determinants for CPR certification and recertification (See Appendix 2).

Limitations

The study will be limited by the amount of research concerning retention of basic cardiopulmonary resuscitation skills and recertification of the same.

Overview of the Remainder of the Thesis

Chapter II will present a review of the literature as it relates to the research problem. Chapter III will describe the instrumentation and methodology utilized and Chapter IV will present an analysis of the data collection. Chapter V will contain a summary, conclusions of the study and recommendations for further research.

CHAPTER II

Review of the Literature

The retention of motor skills cannot be studied in isolation. Skills must be studied firstly in terms of acquisition. The literature related to skill acquisition, and skill retention was reviewed with most research being found in the education literature.

The complex skill of CPR was researched extensively in both education and nursing literature and comprises the major focus of the study.

Motor Skill Acquisition

Skills are a consequence of thinking, learning, training and practice (Hardy, 1980:322). The course of learning for a motor skill depends, among other things, upon the task to be learned: the nature and length of the procedure and the type and number of part-skills that compose the total skill (Gagne, 1977:217).

Typically, the learning curve for a motor skill exhibits a rapid rise in proficiency during its early portion, with a gradual tapering off of improvement as practice proceeds. However, sometimes this learning curve shows an initial gradual increase followed by rapid acceleration as the procedure is being learned. This is especially true if the skill is a complex one such as CPR.

Theories of Motor Skill Acquisition

According to Rhode (1980), a conceptual model for motor skill acquisition is divided into two areas: planning, and implementing. In

the planning area, prerequisite knowledge must be determined by analyzing the skill. Essential and non-essential characteristics of the skill must be analyzed, positive and negative examples of the concept must be identified (to show the student how the skill should and should not be performed), examples must be sequenced, and cues must be constructed to focus student's attention on the essential characteristics. Implementation involves presenting the positive examples, analyzing relevant characteristics, presenting negative examples and providing additional examples for students to classify.

Hardy (1980) states that there are certain facets that affect the process of psychomotor skill learning both from a student and an instructor point of view. Those under student control include: thinking involved in skill learning; feedback (intrinsic and extrinsic); anxiety; and fatigue. As a facilitator, the instructor has control over more facets than students. Augmented feedback is under his control and when it is given concurrently, performance levels are higher than when feedback is given at the end. Therefore, it becomes evident that timing of feedback is crucial to skill learning. Instructors control the environment and novelty and complexity of the skills. It appears that if skills are too easy or too complex, they will not be learned (Hardy, 1980:325). Mode of presentation is under instructor control and it is stressed that students should not be overloaded with details and demonstrations should be complete.

Fitts and Posner (1969:11) state that there are three learning phases associated with the learning of complex skills: cognitive, associative and autonomous. They further note that these phases merge

gradually into each other as learning progresses so that there is no definite transition between them.

In the cognitive phase the learner is developing an executive plan of the skill to be learned, must group together already existing subroutines to produce this executive plan, and must recognize and process relevant environmental cues which affect his skill performance. He must understand the motor problem and what is to be done (Schmidt, 1975:46). According to Fitts and Posner (1969:11-15) it is necessary for the instructor to help the learner to attend to important perceptual cues and response characteristics and to give diagnostic knowledge of results which later go unnoticed in this first phase of skill learning because at this stage behavior consists of a patchwork of old habits ready to be put together into new patterns and a supplement of a few new habits.

The use of visual information by the instructor is also essential during this phase of learning to help organize the plan and aid retention of the environmental cues (Martineuk, 1979:199). Instructions given to students should start out simple and become more complex as the skill is mastered (Schmidt, 1975).

The associative phase follows next and includes dropping the initial cognitive activities and refining the necessary motor movements. In this phase the learner continuously reorganizes the motor behavior until the components go together to form larger components; extraneous movements are dropped; the overall plan of action for the skill becomes clear; and the independent components become coordinated (Martineuk, 1979:188). Errors, which may be frequent at first, are gradually eliminated.

The amount of practice needed to achieve the above depends on the complexity of the skill and the capacities and past experiences of the learner (Hanson, 1972:72). This practice must be accompanied by feedback.

Practice sessions consisting of frequent repetition and frequent rest periods seem to facilitate performance levels. Fitts and Posner (1969) state that if parts of the skill are independent of each other, it may be useful to practice each of these components separately. However, if the parts are interrelated and must be integrated with one another to perform the skill, the skill is best learned as a whole. If the components are too complex to be practiced as a whole but are interrelated, it is more useful to practice the independent parts separately and alternate between whole and part practice until the entire skill performance is satisfactory. Environmental cues, in this phase, should be as close as possible to the actual environment the skill will be performed in and distracting cues should also be introduced so the learner can practice ignoring them.

In the final autonomous phase, the performer responds efficiently, has few errors and has a high efficiency rate. He no longer thinks of what to do next. This stage comes only following a great deal of practice (Schmidt, 1975).

Drowatzky (1975:53) states that motor skill acquisition involves learning about two task components: the muscular response and the perceptual cue. Perceptual cues, resulting from information processing, relate information from the outside world while the muscular

response indicates what to do with the information received. He further states that it is always performance that is measured and when behavior changes have occurred, we infer that learning has taken place.

Garry and Kingsley (1970) state that as an act is repeated it becomes habituated. This occurs by producing progressive changes in various aspects of the total performance. The individual, in the early stages of learning a skill, begins a sequence of actions with a given plan of action. As he repeats the sequences and the sequences become longer, he does not have to consciously think about what to do next. Under repetition, superfluous responses tend to drop out as the performance becomes habituated, movements become smoother and more flowing, and speed and accuracy increase.

Hanson (1977) states that four basic elements constitute a skilled performance. A skilled act: involves a chain of motor responses; requires the coordination of perceptual input with these motor responses; involves a hierarchy of responses; and depends heavily on feedback. The feedback should be both extrinsic and intrinsic.

Motor Skill Classification

Investigators of motor skills have distinguished three important dimensions of motor performance that result from motor skill learning: fine versus gross, continuous versus discrete, and open loop versus closed loop (Gagne, 1977: 207).

The distinction between fine versus gross refers to the amount of body musculature that is involved in the performance. A gross motor

act involves the contraction and usage of the body's large muscles, whereas fine motor acts require extreme precision and consist of movements of certain segments of the body within a limited area (Singer, 1975). Singer (1975:462) further notes that gross motor skills generally are retained for many years at a higher skill level than any other learning, such as fine motor skills or prose.

A closed-loop skill is one that depends entirely upon internal feedback from the muscles as guiding stimuli and could be performed with the eyes closed (Singer, 1975). Because no reference to the environment is needed for the performance of a closed skill, requirements for the skill are predictable (Schmidt, 1975:25) (Singer, 1975:17). Feedback regarding closed-loop skills is given continuously throughout the performance. An example of a closed-loop skill would be the arm movements during external cardiac compression in CPR. Most motor tasks, however, tend to be somewhat open-looped, that is, they are influenced to some degree by external stimuli (the environment) and may vary from one attempt to the next (Gentile, 1972). Feedback regarding open loop skills comes from both internal and external sources and generally comes at the end of the performance. Because the open skill is more complex, it is generally more difficult to learn (Marteniuk, 1979:188).

A discrete motor task is typically one in which a particular movement is made in response to a particular external stimuli (Gagne, 1977:208) (Vanderschmidt, 1975). It may contain one movement or a series of movements with a fixed beginning or end which students must respond to in an all-or-none manner (Drowatzky, 1975:8) (Singer, 1975:19-20).

In contrast, a continuous motor task has no distinct beginning or end and the learner must continually adapt to many stimuli, some of them internal, to keep the system balanced (Fitts, 1969:83) (Gagne, 1977:208) (Vanderschmidt, 1975).

Continuous tasks are often more lengthy than discrete tasks and attempts are made to modify performance by constantly adjusting to errors (Singer, 1975:20). Singer (1975:366) further notes that continuous tasks are retained better than discrete tasks. This may be because there are more opportunities to strengthen the habit in continuous tasks because of repetitive or sustained effort (Oxendine, 1968:127). Therefore, it is more probable that overlearning will occur.

Drowatsky (1975) states that continuous tasks may be remembered better than discrete tasks because they are learned better in the initial practice. Further, discrete tasks may be interfered with more because of the greater amount of cognitive dependence for the skill and the large amount of cognitive learning taking place every day. Continuous skills will probably have less interference.

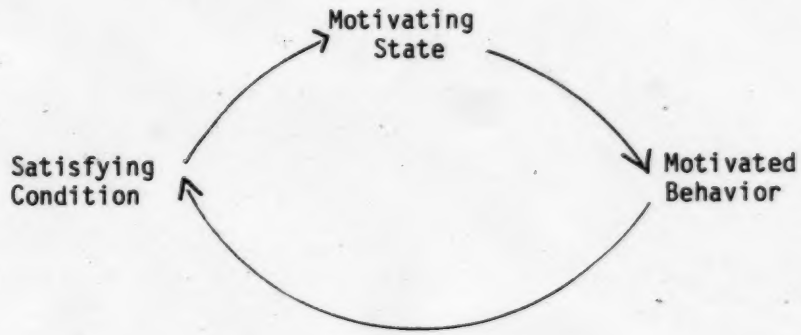
Motivation

We know that people engage in similar activities but for different reasons. From these observations, and from what people do and say, we infer that a motive exists for behavior. Therefore, the study of motivation deals with the conditions that determine our goals and the behaviors that we use to obtain them. Motivation is the energizer of our behavior (Drowatsky, 1975:191).

Actually, motivation is a concept invented to describe the psychological state of the organism as it is affected by various influences. It is caused by various motives (needs or drives), and attainment of the goal removes a particular need (Singer, 1975:407) (Oxendine, 1968:174).

Drowatzky (1975) states that motives can be either primary or secondary. Primary motives are physiological or general in nature and are not dependent upon learning. They include thirst, sleep, hunger, fatigue, temperature regulation and oxygen needs. Secondary motives, on the other hand, are symbolic and are acquired through past experience. These usually include achievement, approval, power, security, acceptance, self-mastery and anxiety (Drowatzky, 1975). Because people differ and therefore so does past experience, it is very difficult to make predictions regarding motivated behavior. Marx and Tombaugh (1967:171) agree that drives do motivate behavior in the sense of initiating and possibly directing behavior.

Motivated behavior represents a cycle with three components: the motivating state, the motivated behavior, and a satisfying state (Drowatzky, 1975:192).



The motivating state may arise from conditions either intrinsic or extrinsic to the person. Goals, determined by the motivating state, therefore, determine the motivated behavior.

Motivation is a prerequisite to any learning and plays an important role during the entire process of skill acquisition. Motivation may be either internal or external. Internal motivation originates from a drive within the person and is termed intrinsic motivation (Singer, 1975:415). An extrinsically motivated person pursues an activity for the material gain he can receive for it. This is termed need-deficiency motivation (Singer, 1975:415) (Oxendine, 1968:172).

Ideally, intrinsic motivation is more desirable than extrinsic motivation, however often both are present to varying degrees. Clifford (1972:135) found that performance on simple tasks can be improved significantly when the learner is extrinsically motivated, whereas intrinsically motivated learners show a greater performance increase on highly complex tasks.

According to Garry and Kingsley (1970), if a motor skill is to be acquired, probably the best motivation is the desire to possess the skill. If this desire is not present, sometimes all that is needed is an explanation of the benefits derived from the skill.

Singer (1975) states that the level of motivation will affect the performance of a complex skill. The Yerkes-Dodson Law describes this phenomenon: there is an optimal level of motivation for the level of task difficulty (Singer, 1975:413).

Singer (1975) goes on to say that for any learning task, motivation must be sufficient so that the learner will attempt the task, especially if it is difficult. Before the task begins, the learner's attitude must be one of mastery of the task and proficient performance.

Singer (1975:414) further notes that the more highly anxious person will learn and perform better if less motivated while the less anxious individual will do better if motivated to a higher degree.

According to Oxendine (1968), an above average level of motivation aids learning and performance in most motor tasks. He notes further that for gross motor tasks requiring speed, strength and endurance, a high motivation level is advantageous.

Oxendine (1968) states that reward and punishment are often used in learning situations to movitate learners. However, these are used most effectively when the learners are well known to the teacher so that the teacher can individualize the use of the techniques to the learners to obtain the most positive responses from the learners.

Singer (1975:419) states that varying the amount of reward appears to produce a change of performance in favor of the greatest rewards. More immediate reward (reinforcement) has been found to be more effective than any delay in reinforcement. It is also important to note that individuals are not all motivated the same way by the same rewards. Therefore, ideally it would be best to individualize the instruction to meet the needs of the learner.

Marx and Tombaugh (1967) state that if a reward or reinforcement follows a correct response during the skill learning, there is greater probability that the response will be repeated.

Singer (1975) further notes that we usually set goals for ourselves before we begin our performance. This is termed level of aspiration and it is affected by past experiences in similar situations. The level of aspiration, if set high enough, may serve as an incentive as long as it is still realistically attainable. Success tends to raise one's aspirational level.

Skill Practice

Probably the most obvious feature of motor skills is that they improve with practice. Practice means repetition of the procedure with intent to improve performance, and with feedback on the performance (Gagne, 1977:217) (Singer, 1975).

Practice is necessary because only by repeating essential movements can the learner be provided with external and internal cues to regulate the performance. As practice proceeds (with feedback), internal cues leading to error are rejected, and internal cues leading to smoothness and precision become established and retained (Gagne, 1977:219).

Distribution of practice may be varied in three ways: length of practice period may be varied, with rest periods constant; length of rest period may vary, with practice periods constant; and varying

arrangements of work and rest period may be combined (Garry and Kingsley, 1970:210).

In general, shorter practice periods produce greater learning. Spaced practice has also been found to be superior to massed practice where the length or amount of material to be learned is the consideration (Garry and Kingsley, 1970:210).

The length of the rest period does not seem to be as important as the fact that rest periods do occur. The optimal length of rest periods vary with the specific skill being learned and within limits, the longer practice period calls for a longer rest period (Garry and Kingsley, 1970:212).

According to Garry and Kingsley (1970:216), when the amount of work involved in a task is great, when the task is complex or not particularly meaningful, when the frequency of error responses is likely to be high, or when motivation is low or amount of effort required high, the practice sessions should be spaced with primary attention devoted to the length of the practice period rather than of the rest period.

In contrast, when the task is highly meaningful or when learning presents the possibility of insight, when the material has been previously learned to a high degree of proficiency but during a prolonged intervening interval the forgetting has been great, when peak performance is required on tasks already well known, or when prolonged warm-up periods are necessary to becoming involved in the task, then massed practice periods are favorable (Garry and Kingsley, 1970:216).

Singer (1975:459) states that it is unfortunate that research dealing with practice-rest ratios has been concerned primarily with motor skill acquisition but rarely goes on to observe retention effects of differing practice conditions.

Continuous or massed practice typically has the effect of depressing the level of performance, which then recovers during subsequent rest periods (Irion, 1969). So far as learning is concerned, massed practice has not been shown to be inferior to distributed practice (Gagne, 1977:226). It appears that the amount of practice, not its distribution, is the important variable in determining the level of learning achieved.

Kleinman (1976) states that, despite the amount of research which has been conducted regarding whether massed or distributed practice is best for skill learning, it is still unknown which is superior. In his study of college students, he attempted to ascertain the effects of massed and distributed practice on the acquisition of three gymnastics skills. The students were divided into two groups, one utilizing massed practice and the other distributed practice, and each group practiced all three skills.

Kleinman (1976) found that there were no significant differences between the massed and distributed practice groups on any of the three skills learned. Kleinman (1972:677) further states that skills most susceptible to the adverse effects of massed practice tend to be externally paced, highly redundant in nature, and low in complexity while those skills in this study were subject-paced, highly complex,

high in uncertainty, and low in redundancy. The skills which comprise a CPR performance are also of the latter type and, therefore, may be learned equally well with either massed or distributed practice sessions.

According to Oxendine (1968:118), most material which has been acquired over a long period of time (distributed practice) will be retained longer than material learned over a shorter period of time (massed practice). He also notes that despite the type of practice utilized, a decrement in the skill occurs very soon after practice ceases. Cratty (1975) notes that massing practice results in greater learning whereas Marteniuk (1979) states that it does not matter whether massed or distributed practice is utilized in skill learning.

Singer (1975) notes that on tests of retention, little difference in performance exists between initially massed or distributed practice.

Cratty (1975:361) states that skill practice may be carried out by either practicing the entire task, practicing the parts of the task, or by the progressive part method where one first practices the initial part, then practices the second part and then practices them together as a whole. This would continue until the entire task is mastered. Generally speaking, it seems that the part method is wasteful of time when the whole method suffices, as time to put the pieces together is not necessary if learning is conducted according to the whole method.

Marteniuk (1979) states that, unless the skill is a very complex one, the whole method of skill practice should be utilized rather

than the part-whole method where students practice separate parts of the skill and then put them together once the parts have been practiced separately.

Singer (1975:382) disagrees, stating that most skills can be taught in their entirety or broken down into parts. Drowatzky (1975) and Singer (1975) state further that it is generally agreed that simple skills should be taught utilizing the whole method while more complex skills should be broken down.

Garry and Kingsley (1970) emphasize that where speed and accuracy are both important to the final performance, they should both be emphasized during practice. This emphasis will help to prepare the learner for what to expect and what is desired of him in the final performance (Singer, 1975:392).

As in the case of CPR where an initial period is spent in demonstration of the performance to be learned, Garry and Kingsley (1970) note that the learners must be able to observe the details of the demonstration and that explanation should accompany complex skill demonstration. The explanation should be simple and concise so as not to overload the learner.

Because one learns what one practices, the practice conditions should be similar to those of the real situation and the procedure should be practiced as realistically as possible.

Mental and Physical Practice

Mental practice refers to the symbolic rehearsal of a physical activity in the absence of any gross muscular movements (Richardson, 1967:95).

Appropriate mental activity can be a necessary aid in the learning and performance of motor tasks. It would seem, therefore, that if physical and mental practice could be continued, tasks may be learned more rapidly, and with a greater understanding of proper performance techniques (Oxendine, 1969:755). The discovery of effective mental rehearsal techniques may enable learners to practice at times when they are not able to actively perform the task.

Oxendine (1969) conducted a study to investigate the effects of different schedules of mental and physical practice on the learning and retention of three motor tasks. Three schedules consisted of different proportions of physical and mental practice and the fourth schedule consisted of practice only. Students were given a training period after which they were performance tested and were retested three weeks later to determine retention of the task.

Results of this study show that the groups utilizing mental and physical practice did as well as the practice groups. Mental and physical practice combined, therefore, can be as beneficial to learning a motor task as physical practice. Up to 50% of the practice time in mental practice can be as effective as 100% of the time in physical practice (Oxendine, 1969:762).

In a study conducted by Beasley (1979:475), physical and mental practice were assessed in skill development in selected chemistry laboratory tasks. The students were divided into four groups - one physical practice group; one mental practice group; one physical and mental practice group; and a control group. Results on a posttest

indicated that for laboratory performance of tasks, a significant difference exists between the control and treatment groups (Beasley, 1979:477). Unexpectedly, mental practice was found to be as effective as physical practice. This may be because of the student's prior experience with the task. Thus mental practice, to be fully effective, should be associated with prior experience of the task (Beasley, 1979:477). Where a skill is unfamiliar to students, teacher demonstration of the complete skill sequence prior to the mental practice exercise may improve the effectiveness of the mental practice.

Stebbins (1968) conducted a study to determine the effectiveness of physical and mental practice on learning a selected motor skill, and possible differential effects of mental practice at different times in the learning period. Students were broken into five groups: control, mental practice, physical practice, mental-physical practice, and physical-mental practice. Results showed that the only significant improvement occurred in the combination-type treatment groups and that either mental or physical pratice was equally effective during the first half of the skill development period (Stebbins, 1968:714).

Cratty (1975) notes that the more complex skills are most improved through mental practice and that those learners who have practiced mentally and physically do better than those who have practiced mentally only.

Drowatzky (1975) states that mental practice seems to be most effective if the learner has had some prior experience with the task or

a task which is similar. Therefore, novice learners should not benefit as much from mental practice as persons with higher skill levels. He also stresses that learners must be taught how to practice mentally.

Feedback

Robb (1968) states that feedback is important in learning because feedback provides the learner with information concerning how his performance compares to the standard. Feedback is error information and can be internal or external; terminal or concurrent.

Robb's study (1968) investigated the course of learning a specified arm movement where the type and frequency of feedback was varied. After several days of practice, criterion testing was conducted which was the same as the learning pattern except that explicit verbal feedback was withdrawn. Students were broken into five groups and utilized different methods for learning the task. Five methods for receiving information regarding the performance were as follows: (a) concurrent visual feedback; (b) concurrent prospective feedback and terminal knowledge of graphs; (c) a combination of (a) and (b); (d) concurrent visual feedback interspersed with passive watching; and (e) concurrent visual feedback at two different speeds.

Results of this study indicated that: the most effective method for learning the task was concurrent visual feedback; slower than normal performances led to deficits on the criterion test; sitting and watching was as effective as watching at two speeds; and during

testing, students in the slow speed group were significantly poorer than other students especially in the timing requirements. The key to effective learning seems to be practice plus feedback.

Marteniuk (1979:196) states that, for learning to occur, an individual attempting to master a skill must have two types of feedback regarding his performance. Knowledge of performance is feedback the individual receives about the actual performance or movements. Knowledge of results is information which the individual uses to assess whether the object of movement was fulfilled. Marteniuk (1979) notes further that either of these types of feedback may be augmented, that is, the feedback may be added to by the instructor informing the learner about his movements, as well as the feedback the person receives internally.

Irion (1969) states that delayed feedback has very little effect upon the learning of discrete skills provided that the learner does not have to make other responses of the same type during the delay. This does not apply to continuous tasks where delayed feedback may be seriously disruptive to the learning and performance process.

In a study carried out by Vanderschmidt (1975), students were separated into two groups. The control group received didactic practice only while the experimental group received didactic training and practice or an automated manniken. Students in the practice group received feedback during the learning practice through feedback devices. These included: lights that told the student whether or not ventilations and compressions were being performed properly; a metronome that

helped establish rate and rhythm; and a strip-chart that traced volume of ventilations and depth of compressions and errors in hand placement. Results indicated that the practice group did significantly better than the no-practice group on initial testing and retention testing.

Motor Skill Retention

Retention is essential if the person is to put to use what he has learned because if the information cannot be recalled on the appropriate occasion, the time spent in learning it has been largely wasted. Therefore, as Stallings (1973:137) states, as educators, our concern is not just to train individuals for current proficiency, but also to ensure sufficient retention so that they can continue to participate long after formal instruction is completed.

A retention curve illustrates the amount of skill which is retained at various points in time following the cessation of practice (Oxendine, 1968:100). The retention of an unpracticed skill or unreviewed verbal learning follows a decelerating curve, that is, it gradually declines over time but never to the base line. Special practice conditions or special skill conditions may result in reminiscence, a temporary rise in the retention curve (Oxendine, 1968).

Theories of Motor Skill Retention

Cratty (1975) discussed four theories of retention: decay, trace transformation, interference, and memory permanence and overlay.

The decay theory which suggests that forgetting and remembering depend primarily on the amount of time which lapses between the initial practice and the retesting, was popular early in this century but has now fallen into scientific disrepute.

Another theory of historical interest is the trace transformation theory which states that forgetting and remembering depend primarily on the changes in the configuration of the memory trace which alters the way skills are remembered.

Interference theory is the most scientifically respectable theory regarding skill retention. Interference theory states that the amount or quality of the skill which is retained depends primarily on the nature of interfering events (Oxendine, 1968). Skills are not forgotten but are altered or obliterated by new experiences. The interfering activity can occur before the learning of the task (proactive inhibition) or can occur after the initial task learning but before the retesting (retroactive interference) (Oxendine, 1968).

Oxendine (1968) and Stallings (1973) state further that if the interfering events are similar to the material to be retained, the retention is altered more seriously than if the interfering events are dissimilar to the material to be retained. With both proactive and retroactive interference, it is the interaction of new experiences with older ones so that the old is not forgotten or the new is not easily retained (Kolesnik, 1976:147).

Many researchers believe that the reason motor skills are retained so well is that there are relatively few interfering motor events in everday life extending from the initial practice to the

retesting session. Most researchers today espouse the interference theory of skill retention, even though relatively little work has been done relating interference theory specifically to motor skills.

Robb (1972:76) states that skills that are highly retained are those in which a high degree of sequential and temporal patterning, or proficiency, has been achieved. There is some evidence that sequences are remembered more readily than temporal patterning. For example, in CPR, sequences are usually remembered but timing tends to be off. Perhaps this is because temporal patterning has been forgotten.

Forgetting frequently involves some sort of distortion. These distortions are of two main kinds: disintegration and assimilation (Kolesnik, 1976). Disintegration includes forgetting some details of an experience but remembering the whole picture and some other details. In assimilation some aspects are retained, some aspects eliminated and some new ones introduced into the original situation. Material seems to be retained best when it fits our frame of reference and is positively reinforcing to us.

Factors Affecting Skill Retention

Oxendine (1968:99) states that, over time, learned material becomes altered in two ways: quantitatively (amount retained) and qualitatively (variations in organization or character of material). Teachers have suspected for a long time that certain types of skills or knowledge are remembered better than others. Gagne and Fleishman (1959) believe that motor skills are retained longer than verbal material perhaps because motor skills are learned more thoroughly to begin with.

Another reason why motor tasks tend to be remembered longer than verbal tasks is that different retention tests are used for each - usually recall for verbal material and relearning for motor skills (Oxendine, 1968).

Singer (1975:453) states that retention may be dependent upon a number of factors: the nature of the task; its meaningfulness to the learner; the time lapse between initial learning and recall; interpolated activities; and the conditions under which the skill was learned.

How much a person retains depends upon a number of factors: his intention to remember; the personal meaning of the material to him; his mental abilities; his level of maturation; his background of experiences; if overlearning has occurred; the frequency of presentation; and what he has previously learned (Kolesnik, 1976).

One of the most important factors in the retention of any type of learning is the degree to which the material is learned initially (Singer, 1975:464) (Cratty, 1975). The degree of original learning is usually stated in terms of: the number of practice trials or amount of time spent in practice; and the degree of proficiency exhibited (Oxendine, 1968:115). With motor skills, proficiency is usually measured in terms of speed, accuracy, distance or number of successful repetitions.

Oxendine (1968:112) further states that meaningful material tends to be retained longer than material which seems disorganized to the learner. The manner in which the material is structured, its relationship to the learner's previous experience and the importance

the individual places on the material all help to determine the degree of retention.

Finer details of the motor skill tend to be forgotten more quickly than the basic features of the skill. It is also known that elements stressed as being most important are more likely to be retained for long periods of time (Oxendine, 1968:113). He states further than when skills begin to deteriorate, fine points which lead to the highest performance levels, are the first to be lost.

It has been found by Oxendine (1968:114) that pleasant skills will be remembered better than unpleasant skills. Similarly, those skills which have been practiced mentally tend to be retained longer. Garry and Kingsley (1970) state that the experiences most easily recalled are those which are emotionally toned, either pleasantly or unpleasantly.

Singer (1975:467) also notes that ultimate skill retention is more dependent upon intervening events than time per se as greater activity brings about the development of competing response tendencies, thus resulting in a higher degree of forgetting.

Overlearning

It is well known that tasks which are well learned are very difficult to forget and are therefore, easily retained. Overlearning refers to the continued practice or study of a task after it has been learned according to some criteria (Oxendine, 1968:115) (Singer, 1975:366).

According to Stallings (1973), the amount of retention of a skill appears to be determined primarily by the degree of proficiency attained during training or the amount of "overlearning". The nature of the skill and the type of activity engaged in during the no-practice interval also appear to have an effect. The degree of proficiency attained would, in large part, be based on the amount of practice the individual has. Oxendine (1968:115) noted that overlearning is applied with the theoretical assumption that it allows the learning that has taken place to "set", (resulting in greater retention) rather than for the purpose of increasing proficiency.

Oxendine (1968:111) also notes that overlearning is more likely to occur with motor skills than among other types of learning. This may be partly due to the fact that some individuals may enjoy the motor task and therefore, practice beyond the point of having learned how to perform the task. Overlearning also tends to result in less interference than for material which has not been overlearned.

Melnick (1971) conducted one of few studies related to overlearning with a motor-learning task. Four groups of subjects practiced balancing on a stabilometer to a specified criterion and were then subjected to either 0, 50, 100 or 200 percent overlearning practice immediately following the attainment of the learning criterion.

Half of each group were retested after one week and half were retested after one month. Results showed that immediate recall of the skill following both sets of retesting was facilitated by overlearning,

with 50% overlearning seen as being as effective as 100% or 200% overlearning. However, if time was given to relearn to the criterion, only the 200% overlearning group showed significantly better scores than the 0% group, and then only after the one month interval.

Melnick (1977) state further that if time is available for a quick review prior to the retesting, overlearning of difficult tasks is not necessary. This is based, in part, on a study conducted by Hammerton (1963) where a difficult tracking task was overlearned by between 90 and 170 trials by one group of subjects while the other group did no overlearning. Hammerton (1963) found that while overlearning improved initial recall of the task, recovery was very rapid for the group which had no overlearning.

It would be helpful to know how much overlearning can produce and predict good retention effects and, therefore, it is surprising that studies dealing with the optimum amount of overlearning are so scarce (Cratty, 1975).

Motor Skill Classification

Almost without exception, motor skills have been shown to be well retained even after intervals of up to two years (Stallings, 1973:139). Small losses which do occur appear to be quickly relearned with practice. Gagne and Fleishman (1959), Stallings (1973) Vanderschmidt (1975), and Cratty (1975) all note that continuous skills are usually retained better than discrete skills even after long periods of no practice. Singer (1975:462) states that this may be

beause there is less interference from other activities; they tend to be overlearned; and errors can be corrected quickly.

CPR involves both discrete and continuous skills. The discrete skills include diagnostic skills such as opening the airway and checking the carotid pulse and continuous skills include ventilations and compressions (Vanderschmidt et al., 1975). Because CPR is a complex of both continuous and discrete skills, retention of the entire performance may be found to be at a fairly low level.

Methods of Measuring Retention

Bahrick (1966:35) states that methods used for measuring retention have changed little from the earliest days of experimental psychology in the 1950's.

Oxendine (1968:104-105) and Robb (1972) state that the most popular techniques for determining the amount of retention are recall, recognition and relearning. Recall is the least sensitive method and asks the individual to draw from his memory without any cues. He must remember what he has learned. Recall can be used quite successfully with some types of skills and usually consists of retesting. However, the individual may draw a blank during recall and not be able to perform the skill at all.

Oxendine (1968) states further that the timing of retention measures is important. In successive recall, the individual is retested after various periods in time after the initial learning has occurred. The retention curve would be plotted based on the individual's score at each retest. One problem with this measure is

that review is likely to occur with each successive retest and therefore, performances may be enhanced.

Single recall may also be utilized to measure skill retention. In single recall, several groups of individuals learn a skill to a desired proficiency and then a different group is retested to check the proficiency at each desired point in time. With this type of measure, performance enhancement is removed because the individual does not have the opportunity for skill review with each retest.

Recognition is more sensitive than recall and will probably give a more accurate indication of the individual's retention. Recognition allows the individual a greater chance of successfully reproducing the correct response by requiring discrimination of several stimuli. Although recognition is frequently used for multiple choice exams, it is not frequently used as a means of determining motor skill retention.

Relearning is the most sensitive of the measures of retention and involves learning something, testing and timing the relearning of the same material. The individual may not be able to recall or recognize any part of a skill, however once he practices the skill again, he will probably find that he can get the feel for it fairly rapidly again. If this does not occur, he will most likely find that relearning the skill takes less time than it did originally.

Recall and recognition tests measure the amount of material remembered while relearning tests measure the time for the initial learning and the relearning and the difference between the two is the amount retained (Kolesnik, 1976). The relearning method usually shows

considerably more retention than do recall or recognition (Kolesnik, 1976:162).

According to Singer (1975:455) the purest measure of skill retention is the one-trial test performed at a later date. This method ensures that relearning cannot occur however it may not be all that reliable as performance tends to fluctuate from trial to trial.

According to Schmidt (1975), the typical experimental design for research studies provides practice for the learner to learn a motor task, a period of no practice (retention interval), and retesting on the task. If the learner is less proficient than on the original test, he is said to have undergone a retention loss.

Cratty (1975) states that traditionally two methods have been utilized to measure skill retention. In the "percentage of gain" method, after a period of no practice, the individual performs the task and the score is compared to the level reached at the completion of the initial learning session to determine if there has been learning or if the initial score was a transitory performance only. The "savings method" consists of looking at the amount of time saved during retesting because of previous practice with the skill.

Schmidt (1975:98) states that retention can be measured in two ways. Absolute retention refers to the level of the performance after the retention interval regardless of where the learner left off after initial practice while relative retention measures how much retention has declined from the original practice to the restesting session. If

absolute retention is being measured, overlearning leads to increased proficiency and if relative retention is being measured, overlearning leads to greater losses over the retention interval (Schmidt, 1975:107).

Skill Retention Studies

Purdy and Lockhart (1962) conducted an experiment to determine retention and relearning of five novel gross motor skills after a nine to fifteen month period of no practice. Subjects were broken into three groups according to ability to learn skills: high, average, and low. For the retesting session no warm ups were given and the subjects performed the skills on three consecutive days. Analysis of their data showed that: a high degree of skill was retained after about one year of no practice (94%); relearning to previously attained levels was rapid after approximately one year of no practice; skill groups retained their positions in learning, retention and relearning; when the proportion of the skill retained and relearned was considered, difference among the groups was small; and there was no significant difference in the retention among the five skills (Purdy and Lockhart, 1962:267-270). Reminiscence was found to be present in one or more skills in 89% of the total group of subjects.

Fleishman and Parker (1962) studied the long-term retention of skills involved in piloting an aircraft. During a six week period, seventeen practice sessions were held. Retesting was conducted after

periods ranging from one to twenty-four months. Results showed that: retention of this perceptual-motor skill was very high, even for periods up to twenty-four months; small losses of retention were recovered in the first few minutes of practice; no drop in the retention curve was shown between the first and fourteenth months, decline was shown at twenty-four months; the most important factor in retention seemed to be level of original learning; and retraining was more effective with distributed rather than massed practice.

CPR Acquisition and Retention

In 1973 the National Academy of Sciences and the American Heart Association determined standards for basic life support, advanced life support and emergency cardiac care (Ellis, 1980:220). Canadian Heart Foundation standards were printed in 1976 and consisted of reprints and modifications of the American standards.

CPR Standards

The goal of initial emergency measures is to maintain ventilation of the lungs and to deliver adequate amounts of oxygenated blood to the brain (Milstein, 1963:106). These initial measures have been described as the A-B-C's of CPR (Chung, 1975:194) (Canadian Heart Foundation, 1976:1):

A - clearing the airway } artificial ventilation
B - instituting breathing } artificial ventilation } cardiopulmonary resuscitation
C - restoring circulation } artificial circulation } cardiopulmonary resuscitation

These steps must be covered rapidly and in the proper sequence because seconds, not minutes, count (Shapter et al., 1976:11). The advantage of CPR is that it permits the earliest possible treatment of cardiac or respiratory arrest by properly trained people (Blaylock, 1977:508).

Artificial Ventilation

Opening the airway and restoring breathing are the basic steps of artificial ventilation (Canadian Heart Foundation, 1976:1). These steps can be performed quickly under almost any circumstance and without the use of equipment or help from another person.

A. Airway

The most important factor for successful resuscitation is the immediate opening of the airway (Canadian Heart Foundation, 1976:1). This can usually be accomplished by tilting the victim's head as far back as possible while he is lying on his back. The rescuer places one hand on the victim's forehead and the other hand under the victim's neck. He then lifts the neck with one hand and presses backward on the forehead (Shapter, 1976:12) (Gordon, 1972:401). This extends the neck and forces the tongue away from the back of the throat. The victim's head must be maintained in this position at all times.

This method is effective in most cases. If it is not effective in opening the airway, the jaw thrust may be required. This can be accomplished by the rescuer placing his fingers behind the angles of the victim's jaw and 1) forcefully displacing the mandible forward

while 2) tilting the head backward and 3) using his thumbs to retract the lower lip to allow breathing through the mouth and nose (Canadian Heart Foundation, 1976:1). This method is usually performed with the rescuer positioned at the victim's head.

B. Breathing

Once a patent airway has been established by means of the head tilt maneuver, the rescuer must ascertain if the victim is breathing. This may be done by observing the victim's chest for movement which may indicate respiration and by the rescuer listening and feeling for air movement in front of the victim's mouth and nose (Shapter, 1976:13). If, after the head-tilt, the victim does not begin breathing on his own, artificial ventilation (rescue breathing) must be started immediately. While maintaing the head tilt, the rescuer seals the victim's nostrils by pinching the nose. The rescuer then takes a deep breath and blows into the victim's mouth. These breaths are repeated four times in quick succession without allowing the victim to exhale between breaths (Shapter, 1976:15-17) (Canadian Heart Foundation, 1976:3).

Where it is not possible to use mouth-to-mouth resuscitation, mouth-to-nose techniques should be utilized. For this technique, the rescuer keeps the victim's head tilted back by placing one hand on the victim's forehead and uses the other hand to lift the victim's lower jaw to seal the lips (Canadian Heart Foundation, 1976:3). The rescuer then takes a deep breath, seals his mouth around the victim's nose and blows until he feels the lungs expand. The rescuer's mouth is removed so he can observe the chest falling.

Immediately after the rescuer establishes a patent airway and quickly gives four full breaths, assessment of circulatory status is initiated (Shapter, 1976:17). Palpation of the carotid pulse is the method of choice for determining cardiac action as it is a central pulse and is easily palpated (Milstein, 1963:97).

While maintaining head tilt with one hand, the rescuer checks the carotid pulse with the other hand. He does this by moving his fingers laterally to the groove between the trachea and neck muscles. Gentle pressure will allow you to feel the pulse. If the carotid pulse is absent, external cardiac compression must be initiated immediately (Shapter, 1976:18) (Canadian Heart Foundation, 1976:4).

C. Circulation (External Cardiac Compression)

External cardiac compression compresses the heart between the sternum and the spine and forces blood out of the heart (Milstein, 1963:112). This produces a pulsatile artificial circulation. The carotid artery blood flow resulting from external cardiac compression is usually about one quarter to one third of normal (Canadian Heart Foundation, 1976:4).

External cardiac compression must always be accompanied by artificial ventilation so the blood that is circulating is being oxygenated.

The Canadian Heart Foundation (1976:5) states that effective external cardiac compression requires sufficient pressure to depress an adult's lower sternum a minimum of one and one half to two inches with the victim lying on a firm surface.

In order to determine hand position for external cardiac compression, the rescuer palpates the lower edge of the rib cage and follows the rib edge to the midline and locates the notch between the two rib margins as they meet. The middle finger is placed in this notch and the index finger is placed superiorly to the middle one. The palm of the other hand is then placed next to the index finger with the fingers of the hand not touching the chest wall. The hand used to palpate the anatomic landmarks is now positioned over the hand on the chest (Shapter, 1976:18) (Gordon, 1972:403) (Canadian Heart Foundation, 1976:5).

The rescuer should be as close to the victim's side as possible with his hands as closely parallel as possible and his shoulders directly over the victim's sternum. This makes use of the weight of the rescuer's body to achieve effective compression which is the pressure required to depress an adult's sternum one and one half to two inches (Blaylock, 1977:510).

Cardiac compressions must be regular, smooth and non interrupted. A slight pause at the end of each compression appears to eject the blood more efficiently (Canadian Heart Foundation, 1976:5) (Shapter, 1976:20). After this pause, the sternum is relaxed so that the ventricles of the heart can fill. The heel of the rescuer's hand, however, should not leave the victim's chest.

Because it is imperative to apply external cardiac compression with artificial ventilation, it is ideal to have two rescuers so that each person can perform one task (Canadian Heart Foundation, 1976:5) (Gordon, 1972:405). The external cardiac compression rate for two

rescuers is 60 compressions per minute and the artificial ventilation rate is 12 per minute (Canadian Heart Foundation, 1976:5) (Shapter, 1976:21). The ventilations must be given during the relaxation phase of the cardiac compression cycle and therefore proper performance of the two man rescue requires training and experience.

For practical purposes, the spoken phrase "one thousand and one" represents approximately one second (Shapter, 1976:21). The cardiac compression rescuer counts out loud the sequence of "one thousand and one, one thousand and two, one thousand and three, one thousand and four, one thousand and five" without pause; he compresses the chest on the words "one, two, three, four, and five" (Shapter, 1976:21). The ventilation rescuer takes a deep breath on the words "one thousand and three", places her mouth over the victim's mouth on the words "one thousand and four", and begins blowing into the victim's mouth on the word "five" (Shapter, 1976:21). Thus, maximum ventilation will occur during the words "one thousand and" of the next cardiac compression cycle.

The two-rescuer method is effective in maintaining circulation as artificial ventilation can occur without any interruption in external cardiac compression. The two rescuers may also exchange functions without any interruption of basic life support. This is accomplished as follows:

1. rescuers will be on opposite sides of the victim;
2. the ventilation rescuer gives a ventilation and moves to a position alongside the victim's chest. She palpates the rib margin and locates the notch with her middle finger. She

places her index finger superior to her middle finger but does not position her other hand.

3. the cardiac compression rescuer continues to count. As soon as he completes three compressions, he removes his hands from the chest. The new compression rescuer slides her hand into position on the victim's chest and places her other hand on top of her bottom hand. She then continues with the fourth compression. The original compression rescuer moves to the victim's head and performs the next ventilation. There should be no interruption of the cardiac compression cycle (Shapter, 1976:20-21) (Canadian Heart Foundation, 1976:5).

CPR may also be carried out effectively if only one rescuer is available to perform both cardiac compression and artificial ventilation. Under these circumstances, interruptions in the cardiac compression cycle are unavoidable. However, CPR should never be interrupted for more than five seconds (Gordon, 1972:407).

The single rescuer performs two quick ventilations for each fifteen compressions (Gordon, 1972:406) (Canadian Heart Foundation, 1976:5). To maintain an effective average cardiac compression rate of 60 per minute, compressions must be performed at a faster rate than in the two-rescuer sequence (Shapter, 1976:21). This faster rate is 80 compressions per minute.

The rescuer must count three consecutive sequences of "one and two and three and four and five," substituting the number "ten" for "five" in the second sequence, and the number "fifteen" for "five" in the third sequence to keep track of the count and to maintain rhythm.

According to Shapter (1976:23), after the number "fifteen" the rescuer immediately gives two full ventilations in five to six seconds and then returns to the cardiac compression cycle.

When the rescuer returns to the cardiac compression cycle, he must quickly locate his hand position using the method outlined earlier.

The fifteen to two ratio applied every fifteen seconds is ideal and should be the goal of one person rescue. However, such a pace is difficult to achieve and maintain except by the very skilled and well-practiced rescuer (Shapter, 1976:23).

Standards (Canadian Heart Foundation, 1976:6) state that the carotid pulse should be checked after the first minute and then periodically during cardiopulmonary resuscitation to check the effectiveness of external cardiac compression or the return of spontaneous heartbeat. CPR should always be continued until the rescuer is too tired to continue, until help arrives, or until the victim recovers.

Complications of CPR

Complications which may be caused by cardiopulmonary resuscitation are, on the whole, acceptable risks as the alternative is death.

The most frequently reported complications are those due to incorrect hand position on the chest of the victim. Rib fractures usually occur because the rescuer's fingers exert pressure on the victim's ribs (Shapter, 1976:28) (Milstein, 1963:119). Liver lacerations, a fairly common and serious risk, also occur as a result of incorrect hand position and result in compression of the xiphoid process of the sternum (Milstein, 1963:119).

A complication which may result from artificial ventilation is distention of the stomach which occurs as a result of too forceful ventilations. This is especially dangerous as stomach contents may be aspirated into the lungs.

Other complications which occur infrequently include perforations of the stomach, ruptures of the heart and lungs, fractures of the sternum, and marrow and fat emboli (Milstein, 1963:119).

In a study conducted by Kaplan and Knott (1964) during autopsies, it was found that 28% of 100 patients had complications resulting from CPR. Rib fractures were the most common and occurred in 24% of these patients. A similar study by Shapir (1968) found that 31% of 62 patients had complications with 13% of these being rib fractures.

In a study of 36 patients conducted by Lawrence et al. (1964:2523), sixty-five complications of closed-chest cardiopulmonary resuscitation were reported. The most common complications were found to be aspiration of stomach contents and rib fractures. Although this number of injuries is not large, they still represent the appreciable danger inherent in the technique (Lawrence, 1964:2530).

It was the observation of these researchers that closed-chest resuscitation is not performed properly by the novice unless he has had prior practice on a manniken under experienced supervision. The question to be answered then must specify after what length of time the rescuer needs to be retrained so that his skills of cardiopulmonary resuscitation are at an accurate and current level so that many of these complications can be prevented.

CPR Skill Acquisition

In the 1960's, the American Heart Association Committee on Cardiopulmonary Resuscitation agreed on details of techniques to be taught, catalyzed training programs and methods, developed manuals and slide-tapes and sponsored a nationwide system to teach cardiopulmonary resuscitation to laymen (Kirimli and Safar, 1972:393). A CPR manual was distributed worldwide. The Laerdahl Company provided training aids, particularly realistic mannikens which made widespread practice possible (Safar, 1974:162). Films helped to disseminate knowledge and to promote acceptance of the new resuscitation techniques.

The basic cardiac life support course is offered to both lay and professional people and provides knowledge and skill in one- and two-person rescue, infant resuscitation, and obstructed airway maneuvers (Ellis and Billings, 1980:220). The standards for this course were developed by the National Academy of Sciences and the American Heart Association in 1973 (Ellis and Billings, 1980:220).

The first American Heart Association CPR Instructors Course was developed in 1965 to provide highly-motivated and skillful persons to teach CPR courses (Kirimli and Safar, 1972).

The traditional CPR course consists of twelve to sixteen hours of concentrated instruction and skill practice. Following one hour of instruction related to warning signs of heart attack and risk factors related to heart attack, demonstrations are conducted regarding one person rescue, two person rescue, infant resuscitation and obstructed airway maneuvers.

CPR instructors then break the group down to a ratio of about one instructor to six students and the students spend the remainder of the course practicing techniques of CPR. Repetition in practice, supervised by instructors, to the point of perfection is necessary for the success of this course. The major deficiency of traditional courses has been inadequate time for supervised manniken practice (Safar, 1974:182). There also tends to be great variability in the quality of the instructors.

The students from the University of Alberta Hospitals School of Nursing who participated in this study were initially taught CPR in the traditional manner. They received an hour of instruction related to warning signs of heart attack and risk factors related to heart attack followed by demonstrations of one and two man CPR, infant resuscitation and obstructed airway maneuvers.

They were then divided into groups with an instructor student ratio of one to six. The remainder of the sixteen hour course was spent practicing CPR techniques to perfection under the direct supervision of the CPR instructor. At the completion of the course the students were given a theory examination and practice examination in accordance with Canadian Heart Foundation standards and were said to be certified in CPR.

In 1972 to 1973, Safar and associates attacked the problem of the need for more instructors by modifying and testing the Laerdahl self-training system which consisted of a new introductory film, recording Resusi-Anne manniken, flip charts and a coaching sound tape (Laerdahl, 1975). This system allows individuals to learn CPR and practice it to perfection in a self learning environment (Meltzer and

Dunning, 1972). It decreases the instructor's involvement with the students, allows the students to progress at their own speed, has built in evaluation of student performance and would facilitate large-scale training of the lay public. This method could also be utilized effectively by people already certified in CPR to practice on their own to to keep their skills at a high level, thereby making recertification much easier.

This system was tested on school children in Pittsburgh and results indicated the same successful performance rates and low potentially injurious performance rates as with the traditional instructor-coached teaching method. One year posttest results indicate a need for periodic retraining (Scott et al., 1976).

In a study conducted at the University of Mississippi Medical Center, medical students were taught CPR utilizing the self-teaching method. Half of the students were also given a criterion performance checklist developed from AHA standards. Students utilized this checklist while they were practicing CPR on the mannikens. Results showed that all students who received the checklist became certified in CPR while only 42% of those who did not receive the checklist became certified (McSwain, Mahan, Herrin, 1979). Indications from this study point out that a very high level of performance can be attained without involving excessive amounts of instructor time.

Berkebile et al. (1975) conducted a study of seventh and eleventh graders comparing four CPR training methods: traditional; self-training with self-practice on a manniken; film viewing only; and film viewing plus self-training with self-practice on mannikens. A control group was given no training at all. Practice performance was

evaluated approximately eleven weeks after the practice sessions. Of the control group, all students failed to pass the practice performance. In general, seventh graders performed best with film viewing plus self-training with self-practice on mannikens, while eleventh graders performed best with the traditional method (Berkebile, 1975:16). The self-learning methods used in this study compare favorably to the traditional instructor method in CPR performance. This study also recommends that certification should be awarded yearly upon demonstration of CPR competence.

The most recent advance in the training of CPR deals with computer technology (Hon, 1982). This system employs a videodisc and computer to teach the individual the skill of CPR. This system will have the capacity to train one to four individuals at any given time with no assistance from a human instructor. The system has the capacity to evaluate each student individually and as an added bonus, it serves as an excellent recertification tool for those already certified in CPR. Using this system two hours a day, 1700 persons may be recertified in one year (Hon, 1982:138).

When this system is certifying four people at a time, the expected duration of the course is about four hours; for recertification after six months about half an hour; and for recertification after one year about one hour (Hon, 1982:138).

This system allows the student to be certified more quickly and at higher standards than a live instructor can achieve. It can also give more precise and immediate coaching as the technology has the ability to get inside the manniken, something a live instructor can never do (Hon, 1982).

Different training programs for CPR have been described above. The most important part of each of these programs is the fact that manniken practice to perfection is mandatory if the rescuer is to be successful in saving lives.

CPR Skill Retention Studies

The Canadian Heart Foundation (1976:10) mandates that CPR courses be required as part of the curriculum of all medical, dental, nursing, respiratory therapy, and other allied health schools. As members of health care professions this mandate is an important one, one that will save lives. Therefore, it becomes even more important to know how long these life-saving skills are retained at the level deemed proficient according to the Canadian Heart Foundation.

Tweed (1980) examined the effects of deliberate overtraining of CPR skills by repetitive manniken practice with the Winnipeg Police Force. Each person received eight hours of CPR training with recording mannikens and then did a written test and performance test on the recording manniken. Each person received instructor certification in BCLS. After a period of 12 to 18 months, personnel were randomly chosen for retesting. One attempt on retesting was allowed. Analysis of performance was based on assessment skills, the call for help before commencing CPR, adequate ventilations, adequate compressions, and potentially injurious performance (Tweed et al., 1980:652).

Results from this study showed that there was a statistically significant ($p < 0.001$) decrement in cognitive knowledge, in ability to perform adequate assessments, and in placing the call for help. There were no decrements in ventilation or compression skills and no changes

in incidence of potentially injurious performance (Tweed et al., 1980:652). Overall performance for those failing however, was generally adequate as these failures would probably only increase the risk of beginning CPR unnecessarily.

On the whole, this study demonstrated that deliberate overtraining of these personnel resulted in satisfactory skill retention for at least one year (Tweed et al., 1980).

In a study carried out by Weaver et al. (1979), lay persons were evaluated six months after completion of a four hour BCLS course to determine the degree to which CPR knowledge and performance skills were retained. The psychomotor performance evaluation was identical to that administered at the conclusion of the initial course. Retention was determined by comparing the follow-up psychomotor performance scores with the scores achieved at the completion of the course (Weaver, 1979:901). The study showed that trainees had lost much of their previously learned knowledge and skills after a period of six months. Recommendations from this study stated that follow-up review and reinforcement must be implemented to ensure retention of knowledge and skills at an adequate level and that organizations offering CPR should recommend recertification and mechanisms for review and recertification (Weaver et al., 1979:902). Once yearly review and recertification is not thought to be adequate.

In a study of the retention of CPR skill among trained Emergency Medical Technicians (EMT's), Deliere and Schneider (1980) found that there is a significant association between CPR technical skills retention and length of time from the last CPR training. EMT's who had completed the CPR course within six months had the highest

passing rate while those who completed the course more than 12 months ago had only a 20.7% pass rate (Deliere and Schneider, 1980:58). It was also found that CPR skills deteriorate rapidly when not reinforced with frequent training and therefore retraining should probably occur quarterly with recertification probably every six months and not less than once yearly (Deliere and Schneider, 1980:60) Further study must, however, be undertaken before this requirement is made mandatory (Deliere and Schneider, 1980:60).

In a pilot program for a study by Vanderschmidt et al. (1975), students were divided into practice and non-practice groups. Practice was provided on an automated manniken. The students were evaluated on their ability to perform CPR within one week and three months after CPR instruction and were also given a multiple choice test.

Three areas determined pass-fail:

1. ability to initiate CPR precisely (checking for breathing; ventilations; checking for pulse and pupils).
2. ability to palpate carotid pulse and to check pulse and pupils on the manniken.
3. ability to perform CPR as single rescuers

In order to pass the practical test students were required to:

1. achieve a minimum of eight ventilations and 45 compressions during a one minute manniken test.
2. count carotid pulse accurately.
3. initiate CPR precisely

A multiple choice examination was also given to the students.

In the immediate testing, 75% of the practice group passed while 94% of the non-practice group failed the practice exams. Retesting completed three months after initial instruction indicated that the practice and non-practice groups were almost identical; only 10% of the practice group and 12% of the non-practice groups passed the practical exam. The loss of learning was especially evident in the required minimum number of ventilations. The skill of initiating CPR and recognizing the pulse were retained well, especially in the practice group.

The previous recommendations of the American Heart Association (AHA) relative to manniken practice and the need for periodic retraining seem to be validated in the pilot group (Vanderschmidt, 1975:27).

The major study, conducted in 1975 by Vanderschmidt et al., had as its objective, the determination of the feasibility of teaching CPR to junior and senior high school students in order to provide for more continuity of emergency services. The key to the study would be whether or not the students would retain the CPR skills once they had initially learned them.

With respect to the retention of the skill of CPR, one must recall the distinction between the discrete and continuous skills in CPR. The discrete skills include opening the airway and checking vital signs while the continuous skills include ventilations and compressions (Vanderschmidt et al., 1975:765).

Once the CPR program had been designed, 400 students were chosen from grades eight and eleven to take part. A control group

received didactic training only while the experimental group received didactic training and practice on an automated manniken.

Evaluation consisted of a multiple-choice exam and a practical test. For the practical testing, students were marked on one and two rescuer CPR using the strip charts. Data not normally collected on the strip chart were also recorded and included checking the carotid pulse, and checking for breathing before initiating CPR both at the end of the training session and again after three months.

The practical test consisted of continuous and discrete skills. Discrete skills included: checking the carotid pulse; opening the airway with the head tilt; lifting the neck; checking for breathing; and finding the pressure point for compressions. Continuous skills included performing ventilation and compressions for one and two rescuer (Vanderschmidt, 1975:770).

Results of this study showed that the practice group did significantly better than the no-practice group on initial testing and retention testing. On initial testing 55% passed the practical test while on the retesting only 31% passed. Vanderschmidt (1975) further noted that students performed better using two person rescue both initially and during retesting with 58% passing initially and 46% on the retesting. Continuous skills were retained quite well while discrete skills were performed correctly 78% of the time initially and only 41% of the time during retesting.

From the above study, it still remained to be shown whether CPR skills could be retained over time or not and therefore be a viable project to pursue for school students. A further study by

Vanderschmidt et al. (1976) sought to ascertain if CPR skills could be retained over time at AHA criterion levels, how well these skills could be retained, and whether or not a film would improve the performance of someone who had received CPR instruction one year ago.

Persons from the previous study participated and the practice group was to be the focus. Half of one group saw the film and half did not. Results showed that retention of continuous CPR skills was almost identical to that observed one year earlier. Retention of ability to measure the carotid pulse was also excellent. According to Vanderschmidt et al. (1976) though, retention of discrete skills continued to decline. There appears to be no difference between the film and no film groups on any component skills. There seems to be value however, in teaching CPR skills to secondary school students because sometimes the ability to perform ventilations and compressions only could save a life. It was recommended in this study that further training programs should be developed to improve the retention of discrete CPR skills.

Barick (1977) carried out a study comparing the retention of CPR skills among lay persons, EMT's and intensive care nurses focusing on when the ability to perform CPR techniques becomes unacceptable in the general public. Findings were based on a cognitive test and practical skill tests and indicated that the general public trained in CPR did retain enough knowledge and skill to perform CPR, that they need to be retrained periodically, and that they can perform CPR as well as some EMT's and nurses for as long as nine months (Barick, 1977:64). On the written examination, the general public retained knowledge about

CPR congruent with standards for about four months (Barick, 1977:64). By the ninth month, a statistically significant amount of information is lost. Based on the above findings, all people trained in CPR may not retain CPR knowledge and skills at recommended acceptable levels for application for as long as one year after initial training (Barick, 1977:64).

Bjorn Lind (1973) conducted a study of CPR retention following a two hour CPR course offered through a hospital. Physicians, nurses and lay personnel had received the initial course and these same groups were included in the retesting session. Approximately one half of the two hundred and seventy initial trainees were retested. Dr. Lind used recording Resusi Anne's for the retesting and he found that two thirds of all groups were able to perform mouth-to-mouth ventilation satisfactorily. Interestingly, for external cardiac compression, physicians and nurses both performed at about 66% while the lay personnel performed at only 35%. It is also interesting to note that failures most often (93%) concerned the most important part of the technique, namely localizing the correct pressure point (Lind, 1973:462).

Braun, Reitman and Florin (1965) conducted a study with laymen on rescue squads to determine if these people could be trained to recognize cardiac arrest and perform CPR properly. These people were given a two hour lecture on cardiac arrest and how to diagnose and treat it. They were then broken into small groups (ten per group) to practice CPR using the Resusi-Anne manniken for a two hour session. At a third session individuals were tested theoretically and practically on CPR. Seventy two percent of those tested passed both exams.

It is not surprising to note that of these who failed, three times as many people failed the practical exam as the theory one (Braun, Reitman and Florin, 1965:3). In order to evaluate the long-term value of the instruction program and the retention of the material, a repeat examination was given eight months later. Seventy-four percent passed this practical exam with 69% performing better than on the initial testing (Braun, Reitman and Florin, 1965:4). One reason for this may have been that these persons were highly motivated because of being on rescue squads and in most cases had practiced on mannikens.

In 1963 Winchell and Safar (1966) proved the ability of lay and paramedical personnel to learn CPR steps A, B and C. Approximately 1,000 trainees were tested. One half received a three hour teaching session without manniken practice and the other half had manniken practice to perfection. Three months later they received a surprise test on a manniken. The total passing rate was 50%, with 12% of the no practice group passing and 30% of those with practice passing (Winchell and Safar, 1966). Specifically, about 75% could feel the pulse adequately, 66% could perform adequate ventilations and about 50% used incorrect hand position during compressions. Therefore, we see that manniken practice to perfection should be mandatory if CPR courses are to more effectively meet the needs of society.

Herman Uhley (1979) reports that within a short period after training, an individual's ability to perform CPR effectively seems to decrease unless he is periodically refreshed on the technique. Ideally, frequent recall classes would help maintain performance, however most people are only willing to devote a limited number of hours

to such programs. The task at hand then, was to develop an inexpensive and practical way of refreshing people's recall of the skill of CPR. In 1977 a wallet-sized card was made available by Mount Zion Hospital and the National Committee for Emergency Coronary Care (Uhley, 1979:518). This card, when tilted, creates moving images of the dynamics of CPR and gives people an easy method for review of the dynamics and fundamental principles of CPR. The front of the card displays three pictures that depict the motions needed for the A-B-C's of CPR and the back of the card has instructions for each step of CPR listed on it. The large number of requests for this card indicates the apparent need for a review of CPR (Uhley, 1979).

A CPR training program was undertaken in a moderate sized community hospital by Gordon (1967). CPR performance was reviewed at retraining sessions six and twelve months after the initial course. At six months there was a significant amount of inadequate performance, and this was greater with nursing and paramedical personnel than with doctors (Gordon, 1967:120). Incidence of inadequacies was further reduced at the twelve month retraining session. Once again, the evidence suggests that retraining or refresher courses which include manniken practice are necessary for all personnel. The frequency of such retraining may need to be regulated on the basis of the professional skill and experience of particular groups but suggestions for non-medical groups include retraining twice the first year and annually after that (Gordon, 1967:230).

CHAPTER III

Design of the Study

This chapter contains a discussion of the design of the study. Sampling, instrumentation and data analysis procedures are explained.

Sampling

The study took the form of practical testing of the retention of a previously acquired motor skill. The population studied consisted of student nurses enrolled in the classes of December '82, April '83, December '83 and April '84 at the University of Alberta Hospitals School of Nursing. It excluded nursing students who were already certified in CPR at the basic level when they entered the nursing program and those whose certification is at the instructor and instructor-trainer levels. Students from the class of December '84 were also excluded from the study as their initial certification was not completed until December, 1982.

Because all students are required to have successfully completed the CPR course early in the nursing program they, therefore, have had their CPR certification for varying time periods. Of the four nursing classes included in the study, the time lapse since initial certification is as follows:

Class Name	Time Since Initial Certification
December '82	18 months
April '83	12 months
December '83	10 months
April '84	6 months

This population allowed the researcher the opportunity to retest a sample from each of the aforementioned groups to determine after which point in time CPR is no longer practiced at the criterion level as specified by the Canadian Heart Foundation.

The researcher initially met with each class of students. The study was described briefly and the students were each given a copy of Questionnaire A to complete (See Appendix 1 - Questionnaire A). They were required to identify themselves by name on the questionnaire so that the population, namely those students certified in CPR since entering the nursing program and whose highest level of certification is at the basic rescuer level, could be determined. All students were informed that the researcher would request the sample chosen to meet with her at a later date.

Class lists of each of the four classes were obtained from the Student Records Secretary at the School of Nursing. These lists contained the names of all persons registered in each nursing class. Students who had filled the questionnaire out incorrectly, those certified before they entered the School of Nursing and those certified beyond the basic rescuer level were eliminated. The remaining student names were numbered beginning with one. The final number on the list indicated the population for that particular nursing class. The population for each of the nursing classes was as follows:

Class Name	Population
December '82	44
April '83	45
December '83	39
April '84	44

It was determined by the researcher that the sample would consist of thirty percent of each nursing class. Utilizing a Table of Random Numbers and entering it at an arbitrary point, thirty percent of the students from each class was chosen for the study sample. The sample size for each nursing class was as follows:

Class Name	Sample Size
December '82	13
April '83	14
December '83	12
April '84	13

The researcher then met with the students selected to participate in the study in order to: request study participation; obtain the written consent of those students who wish to participate (See Appendix 1 - Written Consent Form); inform students regarding date, time and place for testing; ask students not to practice the skill either mentally or physically before the testing; and have the students complete Questionnaire B to determine if students had practiced CPR or had performed CPR on a victim since initial certification (See Appendix 1 - Questionnaire B). From each of the classes, the number who had practiced and/or performed CPR on a victim are listed below:

Sample	Class	Practice	Performance on Victim
13	December '82	1	0
14	April '83	0	1
12	December '83	0	0
13	April '84	0	0

No students from any of the classes chose not to participate in the study. However, if they had, other students would have been chosen randomly to replace them.

Instrumentation

Canadian Heart Foundation criteria were utilized to determine whether students passed or failed the practical testing on the recording Resusi-Anne manniken (See Appendix 2 - Cardiopulmonary Resuscitation Performance Test for One and Two Rescuer CPR). Each of the items listed under the Critical Performance column was marked as to pass or fail during the testing session.

Two CPR instructors were selected to carry out the testing on each of the study participants. These instructors were briefed on the testing sessions and then one practical test was conducted for each of the study participants.

Briefing Session

The briefing session for the CPR instructors was carried out in order to outline the exact protocol to be followed during the testing session to ensure that all study participants were given the same instructions and thus evaluated equally according to Canadian Heart Foundation criteria.

Specifically, it included:

1. a brief description of the purposes of the study, namely to determine CPR skill retention over 6, 10, 12 and 18 months respectively. Retention was analyzed in terms of overall skill performance; continuous versus discrete skills; and practice versus no practice (on either a victim or a manniken).
2. an explanation of the exact testing procedure to be followed.

a. The student entered the room and the recording Resusi-Anne manniken was lying on the floor.

b. The instructor stated that Annie had just collapsed and that they were to begin resuscitation procedures as soon as the starting point on the tape was marked by thumping Annie's chest once.

c. One instructor observed the student's one and two man performance according to Canadian Heart Foundation criteria and the other instructor came in as a second rescuer after one complete sequence of one man CPR was completed by the student and the instructor stated "I know CPR, can I help?" Four sequences of two man CPR were completed before the first instructor stopped the test. That is, the study participant and instructor were each required to complete two changeovers from ventilations to compressions and compressions to ventilations to complete the testing (four cycles).

3. an explanation regarding the instruments to be utilized during the testing.

The CPR performance checklist was utilized to ensure that all aspects of the performance were completed by the study participant in the correct sequence. This checklist had been approved by the Canadian Heart Foundation for use in determining CPR certification and as such has proven to be a reliable tool.

The instructor marking the CPR performance checklist was required to indicate pass or fail in the appropriate column on the sheet for each aspect of the critical performance. After the testing

was completed, the checklist was utilized by the researcher to break the skill of CPR down into the discrete and continuous aspects of the performance.

The tapes produced by the recording Resusi-Anne manniken represent a written record of the actual physical performance of the person performing the skill of CPR. Following the testing session, the recording Resusi-Anne tapes were marked by both instructors together according to Canadian Heart Foundation standards.

Together, the CPR Performance Checklist and the recording Resusi-Anne tape present an accurate picture of the actual CPR skill performance in terms of all aspects of CPR.

Practical Testing

The practical testing began immediately upon the student compressing the recording Resusi-Anne chest plate once. No coaching was given to the study participants during any portion of the testing.

The testing session proceeded as outlined in the briefing session with each study participant having ten minutes for the testing.

Data Analysis

The practice questionnaire, recording Resusi-Anne tapes and CPR performance checklists provided the raw data for the study. These data were analyzed separately and collectively to determine:

1. overall skill performance in accordance with Canadian Heart Foundation standards. Specifically, did the participant

perform the skill of CPR at or above the criterion level published by the Canadian Heart Foundation?,

2. the performance of the continuous and discrete aspects included in the performance of CPR; and
3. if practice since initial certification, either on a victim or on a manniken, had any effect on the performance of CPR.

Overall Skill Performance

Overall skill performance was measured by an analysis of the recording Resusi-Anne tapes and the CPR Performance Checklist. The tapes were marked according to Canadian Heart Foundation criteria and included one and two man CPR. (See Appendix 3 for the specifics of marking of the tapes for one and two man CPR). Tapes were given either a pass or fail by the CPR instructors. Results of overall skill performance for each group are presented in terms of frequencies and percentages of those who passed.

Continuous and Discrete Skill Retention

The checklist utilized contained aspects of CPR performance. Following the testing, these checklists indicated which aspects of CPR were performed correctly and in the proper sequence. However, some aspects of CPR performance cannot be analyzed without analyzing the tapes as well. These include depth of respirations, depth of and continuity of compressions, and timing. Therefore, both the CPR performance checklist and the recording Resusi-Anne tapes were analyzed to determine the performance of continuous or discrete CPR skills.

Continuous CPR skills include ventilation depth, chest compression depth and continuity, and four cycles of one man and two man CPR. These continuous skills were analyzed as either passing or failing according to Canadian Heart Foundation criteria.

Discrete CPR skills include: shake and shout; look, listen, feel; initial four ventilations; checking the carotid pulse; calling for help; hand position; one minute pulse check; initiation of two man CPR; two man switchover; and timing utilizing both or either of the tapes and performance checklists. The performance checklists were used to analyze those discrete aspects of the performance which cannot be seen on the tape, namely, shake and shout; look, listen, feel; checking the carotid pulse; calling for help; and the one minute pulse check. The remaining discrete aspects including the initial four ventilations, hand position, initiation of two man CPR, the two man switchover and timing were analyzed using both the tapes and the performance checklist.

Both the continuous and discrete aspects of the skill of CPR are presented for each of the groups in the study in terms of frequencies and percentages.

Practice Since Initial Certification

Practice on either a real victim or a manniken was determined by Questionnaire B. Results of those who had had either victim or manniken practice was discussed in terms of overall skill performance and discrete/continuous skill retention.

CHAPTER IV

Analysis of the Data

This chapter on data analysis consists of three sections. The first is a presentation of the overall skill performance of each of the groups on one and two man CPR. The second is a presentation of each of the groups in terms of the discrete and continuous aspects of the skill of CPR. The third is a discussion of the results of each of the members who had practiced CPR, either on a victim or manniken, since certification.

Overall Skill Performance

Table I indicates the frequency and percentages of passes and failures for each of the four classes for one man CPR. The results indicate that all students in each sample failed one man CPR overall with the exception of one student. The student who passed one man CPR had taken her initial course ten months ago and was from the Class of December '83.

Table II indicates the frequency and percentages of passes and failures for each of the four classes for two man CPR. The results indicate that only one student from all classes passed two man CPR according to Canadian Heart Foundation criteria. This student was from the Class of April '83 and had taken her initial course twelve months ago.

It is very interesting to note that there were no overall passes from those groups which had taken their initial courses either

Table I

Overall Skill Performance

One Man CPR

Time Since Initial Certification	Pass		Fail	
	f	%	f	%
18 months	0	0%	13	100%
12 months	0	0%	14	100%
10 months	1	8.3%	11	91.7%
6 months	0	0%	13	100%

Table II

Overall Skill Performance - Two Man CPR

Time Since Initial Certification	Pass		Fail	
	f	%	f	%
18 months	0	0%	13	100%
12 months	1	7.1%	13	92.9%
10 months	0	0%	12	100%
6 months	0	0%	13	100%

six months or eighteen months previously. Further it seems curious that only one student out of a total of fifty two or 1.9% of the total sample passed either one or two man CPR.

Retention of the Discrete Aspects of CPR Performance

Tables III, IV, V and VI indicate the frequencies and percentages of passes and failures for each of the four classes for the discrete aspects of CPR performance.

Discrete Skill Retention After Eighteen Months

Table III indicates that the only discrete skills performed at or above Canadian Heart Foundation standards by those students who had initially been certified eighteen months earlier were: shake and shout, and look, listen and feel. These two aspects were performed correctly by all study participants.

The initial four ventilations were performed correctly by 69.2% of the study participants. Those who failed did so because of three errors: one student performed three ventilations only; two students performed only two ventilations and one student did not ventilate the manniken at all.

Students were checking the carotid pulse 76.9% of the time once they had completed the four ventilations. Those who failed this aspect of the performance did not check the carotid pulse at all. In these instances CPR was then instituted without knowing for certain that the victim had, in fact, suffered a cardiac arrest. Three students or 23.1% did not call for help.

Table III

Discrete Aspects of CPR Skill Performance

Eighteen Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Shake and shout	13	100%	0	0%
Look, listen and feel	13	100%	0	0%
Initial four ventilations	9	69.2%	4	30.8%
Checking carotid pulse	10	76.9%	3	23.1%
Calling for help	10	76.9%	3	23.1%
Hand position	8	61.5%	5	38.5%
One minute pulse check	10	76.9%	3	23.1%
Initiation of two man CPR	10	76.9%	3	23.1%
Two man switchover	2	15.4%	11	84.6%
Timing				
initial assessment	8	61.5%	5	38.5%
initial pulse check	4	30.8%	9	69.2%
one minute pulse check	3	23.1%	10	76.9%
one man CPR	5	38.5%	8	61.5%
two man CPR	10	76.9%	3	23.1%

Hand position on the manniken was correct 61.5% of the time. The 38.5% who did not have their hands placed correctly on the sternum all had their hands placed too low on the manniken (over the xiphoid process) thereby increasing the probability of injury to internal organs.

The one minute pulse check was performed by 76.9% of the students. The other 23.1% did not check the pulse after completion of one minute of CPR to ascertain if the pulse had been restored.

Initiation of two man CPR was performed correctly by 76.9% of the students. Those who failed to initiate two man CPR correctly presented the following errors: one student did not initiate at all, that is she continued with one man; one student, when the second rescuer said 'I know CPR, can I help', did not say the words to indicate she wanted the second rescuer to help; and the third student changed her compression rate before the second rescuer had given her first breath.

The two man switchover was performed correctly in 15.4% of the tests. It included calling for the switch and performing the switch at the correct time, first from compressions to ventilations and then from ventilations to compressions. Three students did not perform the switchover at all. Of the remaining eight who failed, five switched from compressions to ventilations incorrectly: three moved to begin ventilations too soon (immediately after the call for switch); and two switched too late (continued with compressions after the three count). The remaining three students performed both switchovers incorrectly. Two switched from compressions to ventilations too late and from

ventilations to compressions too soon and one switched from compressions to ventilations too soon and from ventilations to compressions too late.

Timing was analyzed for five aspects of the performance according to Canadian Heart Foundation standards: initial assessment; initial pulse check; one minute pulse check; one man CPR; and two man CPR.

Initial assessments were performed within the time limits by 61.5% of the students. Of those who failed, three assessed the victim for too short a period of time while two assessed for too long.

The initial pulse check was performed in the specified time by only 30.8% (or four) of the students. Six students did not check the carotid pulse for long enough; one checked it for too long; and two students did not check the pulse at all.

The one minute pulse check was performed in the seven to ten second time limit by only 23.1% of the students. Seven students' times were too short and three did not check the pulse at this time.

Overall timing for one man CPR was within the standards set out by the Canadian Heart Foundation in 38.5% of the tests. The eight students who failed all took too much time to complete one man CPR (68 to 99 seconds).

Timing for two man CPR overall was performed correctly by 76.9% of the students. Two students performed too slowly and one student did not perform two man CPR at all.

Table IV

Discrete Aspects of CPR Skill Performance

Twelve Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Shake and shout	14	100%	0	0%
Look, listen and feel	12	85.7%	2	14.3%
Initial four ventilations	7	50%	7	50%
Checking carotid pulse	8	57.1%	6	42.9%
Calling for help	10	71.4%	4	28.6%
Hand position	12	85.7%	2	14.3%
One minute pulse check	6	42.9%	8	57.1%
Initiation of two man CPR	8	57.1%	6	42.9%
Two man switchover	2	14.3%	12	85.7%
Timing				
initial assessment	9	64.3%	5	35.7%
initial pulse check	3	21.4%	11	78.6%
one minute pulse check	1	7.1%	13	92.9%
one man CPR	6	42.9%	8	57.1%
two man CPR	8	57.1%	6	42.9%

Discrete Skill Retention After Twelve Months

Table IV indicates discrete skill retention for the group twelve months since initial certification. Those students certified in CPR twelve months prior to the retesting performed with 100% accuracy on the shake and shout aspect of CPR only. Look, listen and feel was performed with 85.7% accuracy with two of the students not performing this at all.

The initial four ventilations were performed by 50% of the students correctly. Of the seven students who failed this aspect of CPR, four did not give the initial four ventilations, two students gave three ventilations and one student gave five.

Eight students (or 57.1%) checked the carotid pulse correctly. Six students did not check the carotid pulse prior to the initiation of compressions.

Ten students (71.4%) called for help. Four students did not initiate the call for help.

Hand position was correct for 85.7% (12) of the students. Two students (14.3%) placed their hands on the chest of the manniken without carrying out proper landmarking to ensure a safe CPR performance.

The one minute pulse check was carried out correctly by six (42.9%) students. Eight students (57.1%) did not check the carotid pulse after the initial minute of CPR.

Initiation of two man CPR was carried out correctly by 57.1% (8) students. Of the six (42.9%) who failed, four students changed the rate of compression too soon, one student did not change her compression rate soon enough and one student did not initiate two man CPR at all.

The two man switchover was performed correctly by 14.3% (2) of the students. Of the twelve who failed, four did not perform the switchover, four switched too soon from compressions to ventilations, and two switched from ventilations to compressions too late.

Initial assessment timing was accurate in 64.3% of the performances. Four students took too long to perform their initial assessments, and one student did not take long enough.

Initial pulse checks were performed correctly 21.4% of the time. Six students did not do initial pulse checks and five students did not assess for a long enough time period.

The one minute pulse check was performed accurately by one (7.1%) student. Of the thirteen who failed, four did not check the carotid pulse following one minute of CPR and the nine who did, did not check it for a long enough time.

Timing of one man CPR was accurate on 42.9% of the tests. Three students took too long to perform one man CPR while five completed it too quickly.

Two man CPR was performed within the time limit by 57.1% of the students. It was performed too slowly by five students and too quickly by one student.

Discrete Skill Retention After Ten Months

Table V indicates the retention of the discrete aspects of CPR ten months following initial CPR certification. Shake and shout and look, listen and feel were performed by all twelve students correctly.

Table V

Discrete Aspects of CPR Skill Performance

Ten Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Shake and shout	12	100%	0	0%
Look, listen and feel	12	100%	0	0%
Initial four ventilations	8	66.7%	4	33.3%
Checking carotid pulse	8	66.7%	4	33.3%
Calling for help	6	50%	6	50%
Hand position	10	83.3%	2	16.7%
One minute pulse check	5	41.7%	7	58.3%
Initiation of two man CPR	8	66.7%	4	33.3%
Two man switchover	5	41.7%	7	58.3%
Timing				
initial assessment	5	41.7%	7	58.3%
initial pulse check	2	16.7%	10	83.3%
one minute pulse check	2	16.7%	10	83.3%
one man CPR	7	58.3%	5	41.7%
two man CPR	8	66.7%	4	33.3%

The initial four ventilations were performed correctly by eight students or 66.7% of the sample. Three students did not complete these ventilations at all and one student performed only three ventilations.

The carotid pulse was checked by 66.7% of the sample. Four students did not check the carotid pulse to be certain that cardiac arrest had actually occurred. The call for help was completed by 50% of the students while the other 50% did not call for help.

Ten students (83.3%) utilized correct hand position while performing CPR while two students did not landmark according to the established procedure as outlined by the Canadian Heart Foundation and therefore may cause damage to a victim.

The one minute pulse check was performed by 41.7% of the group. Seven students (58.3%) did not complete a pulse check following one minute of CPR performance.

Initiation of two man CPR was performed correctly by 66.7% (8 students) of the group. Of the four who failed to initiate two man CPR correctly, three changed the rate of compression before the second rescuer had given the initial breath and one did not alter the rate of compression once the initial breath by the second rescuer had been given.

Five students (41.7%) performed the two man switchover correctly. Of the seven who failed this aspect, three did not perform the switchover at all, two switched from compressions to ventilations correctly but switched too soon from ventilations to compressions, and two switched from compressions to ventilations too soon but switched back correctly.

Initial assessment times were within Canadian Heart Foundation criteria in 41.7% of the cases. Two students did not allow adequate time for the assessment and five students took too long to complete the assessment.

Only two students (16.7%) utilized the correct time to complete the initial pulse assessment. Six students did not take adequate time for the pulse asseessment, one student took too long, and three students did not check the carotid pulse.

The one minute pulse check was completed within the time limits by two students (16.7%). Of the ten students whose time for this assessment was considered a fail, seven students did not do an assessment, and three did not assess for a long enough period of time.

Overall time for completion of one man CPR was adequate for 58.3% (7) of the students. Of the five who failed, one student performed too quickly and four performed too slowly.

Timing for two man CPR was performed adequately by eight students (66.7% of the sample). All the four whose time was inadequate performed two man CPR compressions at too fast a rate.

Discrete Skill Retention After Six Months

Table VI indicates the retention of discrete skills six months after initial CPR certification. All of the students performed shake and shout correctly. Look, listen and feel was performed correctly by 92.3% (12) of the students. One student (7.7%) did not perform this aspect of CPR.

Table VI

Discrete Aspects of CPR Skill Performance

Six Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Shake and shout	13	100%	0	0%
Look, listen and feel	12	92.3%	1	7.7%
Initial four ventilations	8	61.5%	5	38.5%
Checking carotid pulse	9	69.2%	4	30.8%
Calling for help	9	69.2%	4	30.8%
Hand position	10	76.9%	3	23.1%
One minute pulse check	7	53.8%	6	46.2%
Initiation of two man CPR	6	46.2%	7	53.8%
Two man switchover	5	38.5%	8	61.5%
Timing				
initial assessment	7	53.8%	6	46.2%
initial pulse check	4	30.8%	9	69.2%
one minute pulse check	1	7.7%	12	92.3%
one man CPR	4	30.8%	9	69.2%
two man CPR	8	61.5%	5	38.5%

The initial four ventilations were performed by eight students or 61.5% of the group. Of the five students who failed this aspect, three students did not give any ventilations, one student gave two and one student gave three initial ventilations. Nine students (69.2%) called for help and four (30.8%) did not.

Hand position for performance of the compressions was correct for 76.9% of the students. Three students placed their hands incorrectly due to no landmarking on the manniken prior to beginning compressions.

The one minute pulse check was performed by seven students (53.8%) while six of them did not check the pulse after a sequence of one man CPR.

Six students (46.2%) initiated two man CPR correctly. Of the seven who did this incorrectly, four changed their compression rates too soon (before the second rescuer gave the first breath), two changed the rate too late, and one did not initiate two man CPR at all.

The two man switchover was performed correctly by five students (38.5%). Of the eight who failed, one student did not switchover, three switched too late on both changeovers, one switched too soon on both changeovers, one switched too soon on compressions to ventilations and too late on ventilations to compressions, one switched too late on compressions to ventilations and switched correctly on ventilations to compressions, and one switched too soon on compressions to ventilations and switched correctly on ventilations to compressions.

Timing on the initial assessment was adequate on 53.8% of the tests (7 students). Of the six whose timing was off, four assessed for

too long a period of time while two did not assess for long enough.

Initial pulse checks were adequately performed by four students (30.8%). Nine students did not assess the carotid pulse adequately with one student assessing too long, three not completing the assessment at all, and five not assessing for long enough.

The one minute pulse check was adequately performed by one student (7.7%). Of the twelve students who did not check this pulse adequately, five assessed the pulse for too short a period of time and seven did not do the assessment at all.

Overall timing for one man CPR was adequate for four students (30.8%). Of the nine whose timing was off, three performed CPR too slowly and six performed too quickly.

Timing for two man CPR was adequate 61.5% of the time (8 students). Four students performed two man CPR at too fast a rate and one student did not perform two man CPR at all.

Discrete Skill Retention Overall

Table VII represents a comparison of the four classes of students for each of the discrete aspects of CPR performance. Interestingly, the group with the highest percentages for the majority of the discrete aspects of CPR performance was the group certified eighteen months ago. This group performed below Canadian Heart Foundation standards for all aspects except shake and shout and look, listen and feel but did perform with the greatest degree of accuracy on the following: initial four ventilations; checking the carotid pulse; calling for help; the one minute pulse check; initiation of two man

Table VII

Discrete Aspects of CPR Skill Performance

Six, Ten, Twelve and Eighteen Months After

Initial Certification - Percentage Passing

	Six Months	Ten Months	Twelve Months	Eighteen Months
Shake and shout	*100%	*100%	*100%	*100%
Look, listen and feel	92.3%	*100%	85.7%	*100%
Initial four ventilations	61.5%	66.7%	50%	*69.2%
Checking carotid pulse	69.2%	66.7%	57.1%	*76.9%
Calling for help	69.2%	50%	71.4%	*76.9%
Hand position	76.9%	83.3%	*85.7%	61.5%
One minute pulse check	53.8%	41.7%	42.9%	*76.9%
Initiation of two man CPR	46.2%	66.7%	57.1%	*76.9%
Two man switchover	38.5%	*41.7%	14.3%	15.4%
Timing				
initial assessment	53.8%	41.7%	*64.3%	61.5%
initial pulse check	*30.8%	16.7%	21.4%	*30.8%
one minute pulse check	7.7%	16.7%	7.1%	*23.1%
one man CPR	30.8%	*58.3%	42.9%	38.5%
two man CPR	61.5%	66.7%	57.1%	*76.9%

*highest percentage

CPR; timing for the initial pulse check; timing for the one minute pulse check; and timing for two man CPR.

The twelve and ten month groups each performed most accurately on two discrete aspects of CPR: hand position, and timing for the initial assessment for the twelve month group; and two man switchover, and timing for one man CPR for the ten month group.

The six month group performed equal to the eighteen month group on timing for the initial pulse check but below other groups for all other discrete skills except shake and shout where they were equal to the other groups.

Results indicate that although most discrete aspects of CPR performance are performed below Canadian Heart Foundation standards as early as six months after the initial CPR certification, the group displaying the highest scores is the group which had completed initial certification eighteen months previously. However it must be noted that, even though their scores were the highest among the four groups, they still represent dangerously low levels of performance of a life saving skill.

Retention of the Continuous Aspects of CPR Performance

Tables VIII, IX, X and XI refer to the retention of the continuous aspects of CPR performance eighteen, twelve, ten and six months after initial certification.

Continuous Skill Retention After Eighteen Months

Table VIII indicates the retention of continuous aspects of CPR performance eighteen months after initial certification. Ventilatory

Table VIII

Continuous Aspects of CPR Skill Performance

Eighteen Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Ventilations depth	6	46.2%	7	53.8%
Compressions depth	4	30.8%	9	69.2%
Compressions continuity	12	92.3%	1	7.7%
Four cycles of 15 compressions and 2 ventilations	10	76.9%	3	23.1%
Four cycles of 5 compressions and 1 ventilation	12	92.3%	1	7.7%

depth was adequate in only 46.2% of the retestings or six students. Of the seven students who did not perform ventilations properly, six students did not ventilate deeply enough and one ventilated with too much force. Ventilations which are too shallow do not ensure that the blood becomes properly oxygenated. Heavy ventilations, on the other hand, may cause damage to the lungs, lead to gastric distention, and interfere with compressions.

Compression depth was adequate in only 30.8% of the group or four students. Compression depth was inadequate for nine students with seven students compressing too lightly and two students compressing too heavily. If compressions are too light, the heart may not be compressed sufficiently between the sternum and the spine and the blood will not be forced out of the heart as effectively. Compressions which are too heavy may injure the heart muscle as it is compressed between the sternum and spine.

Twelve students (92.3%) performed compressions continuously. One student did not come off the manniken between compressions resulting in some pressure always being applied to the chest both during compressions and during the relaxation between compressions.

The four cycles of fifteen compressions and two ventilations, or one sequence of one man CPR, were performed by 76.9% or ten students. One student performed five cycles, one student only performed ten compressions for each cycle and one student only performed three cycles of compressions and ventilations to complete sequences of one man CPR.

For two man CPR, twelve students or 92.3% performed four cycles of five compressions and one ventilation. The student who failed this

aspect of the performance did so because she did not initiate two man CPR at all.

Continuous Skill Retention After Twelve Months

Table IX indicates continuous skill retention ten months after initial certification. Table IX indicates that only two students or 14.3% performed ventilations at a safe depth. Of the twelve who failed, eleven failed to get an adequate amount of air into the manniken's lungs and one ventilated too heavily.

Compression depth was also performed poorly by this group. Only one student or 7.1% passed this aspect. Thirteen students performed compressions which were too light, that is they were not compressing the heart adequately to ensure sufficient blood being pumped to the victim's body.

Compression continuity was demonstrated by nine students. Four students were not allowing the ventricles of the heart to fill completely between compressions and one student hesitated on the compression before the ventilation on two man CPR.

Eleven students (78.6%) performed four cycles of fifteen compressions and two ventilations for one man CPR. One student performed only three cycles, one performed two cycles and one performed only five compressions for each cycle.

The four cycles of five compressions and one ventilation were performed correctly by all fourteen students for the sequence of two man CPR.

Table IX

Continuous Aspects of CPR Skill Performance

Twelve Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Ventilations depth	2	14.3%	12	85.7%
Compressions depth	1	7.1%	13	92.9%
Compressions continuity	9	64.3%	5	35.7%
Four cycles of 15 compressions and 2 ventilations	11	78.6%	3	21.4%
Four cycles of 5 compressions and 1 ventilation	14	100%	0	0%

Continuous Skill Retention After Ten Months

Table X indicates continuous skill retention ten months after initial CPR certification. Table X indicates that only three students or 25% performed ventilations at an acceptable depth. Of the nine who failed, four performed all ventilations too shallowly, four performed ventilations on one man CPR satisfactorily but too shallowly on two man, and one student ventilated the manniken too heavily on both one and two man CPR.

Compression were performed correctly at an alarmingly low rate. Only one student performed according to Canadian Heart Foundation standards. Eleven students or 91.7% performed compressions inadequately. Of these, four students compressed too lightly on both one and two man CPR, and seven compressed adequately on one man but too lightly on two man CPR.

Ten students or 83.3% performed compressions with continuity. The remaining two failed to allow the sternum to relax between compressions.

The four cycles of fifteen compressions and two ventilations were performed by 92.3% of the students. One student only performed three cycles to complete her sequence of one man CPR.

All of the students (100%) performed four cycles of five compressions and one ventilation to complete their sequence of two man CPR.

Continuous Skill Retention After Six Months

Table XI indicates continuous skill retention six months after initial certification. Table XI indicates that only three students or

Table X

Continuous Aspects of CPR Skill Performance

Ten Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Ventilations depth	3	25%	9	75%
Compressions depth	1	8.3%	11	91.7%
Compressions continuity	10	83.3%	2	16.7%
Four cycles of 15 compressions and 2 ventilations	11	91.7%	1	8.3%
Four cycles of 5 compressions and 1 ventilation	12	100%	0	0%

Table XI

Continuous Aspects of CPR Skill Performance

Six Months After Initial Certification

	Pass		Fail	
	f	%	f	%
Ventilations depth	3	23.1%	10	76.9%
Compressions depth	1	7.7%	12	92.3%
Compressions continuity	11	84.6%	2	15.4%
Four cycles of 15 compressions and 2 ventilations	11	84.6%	2	15.4%
Four cycles of 5 compressions and 1 ventilation	12	92.3%	1	7.7%

23.1% performed ventilations correctly. Of the ten who failed, five demonstrated ventilations which were too shallow on both one and two man CPR, four performed adequate ventilations on one man but ventilations which were too shallow on two man, and one ventilated too heavily on one man but ventilated adequately on two man CPR.

Compression depth was poorly demonstrated by this group of students. Only one compressed adequately and twelve failed this aspect of CPR. Seven students compressed too lightly on both one and two man CPR, four compressed adequately on one man but were too light on two man and one student compressed too heavily on one man and too lightly on two man CPR.

Compression continuity was demonstrated by eleven students or 84.6% of the sample. Two students demonstrated camping (not allowing complete relaxation of the sternum) on one man CPR.

Eleven students completed the one man sequence of fifteen compressions and two ventilations correctly. One student performed only three cycles of compressions and ventilations and one student completed five cycles of five compressions and two ventilations.

The four cycles of five compressions and one ventilation for two man CPR were performed corrrectly by twelve students, or 92.3% of the sample. One student did not perform two man CPR at all.

Continuous Skill Retention Overall

Table XII indicates a comparison among the four groups in terms of percentage of students passing each of the continuous aspects of CPR performance.

Table XII

Continuous Aspects of CPR Skill Performance

Six, Ten, Twelve and Eighteen Months After

Initial Certification - Percentage Passing

	Six Months	Ten Months	Twelve Months	Eighteen Months
Ventilations depth	23.1%	25%	14.3%	*46.2%
Compressions depth	7.7%	8.3%	7.1%	*30.8%
Compressions continuity	84.6%	83.3%	64.3%	*92.3%
Four cycles of 15 compressions and 2 ventilations	84.6%	*91.7%	78.6%	76.9%
Four cycles of 5 compressions and 1 ventilation	92.3%	*100%	*100%	92.3%

*highest percentage

Overall, both compression and ventilation depth were performed poorly by all groups with the group certified eighteen months ago demonstrating the highest percentages at 30.8% and 46.2% respectively. The remaining three continuous aspects of CPR performance were performed with more accuracy by all four groups.

Ventilatory depth may have been performed poorly because of inadequate tilting of the manniken's head. This could account for the fact that, of the students who failed, the majority of them demonstrated ventilations which were too shallow.

Compressions were also not heavy enough for the majority of the students who failed. It is interesting to note that many of those who failed compressed adequately for one man CPR and too lightly for two man. This may be due to the fact that the students were becoming physically tired in the latter part of the performance.

The higher passing rates of compression continuity, the sequence of one man CPR and the sequence of two man CPR may indicate that the students do perform the repetitive aspects of the CPR performance best.

CPR Performance Following Practice

Table XIII depicts overall skill performance, discrete aspects of the performance, and continuous aspects of the CPR performance for the two students who had practiced CPR since their initial certification.

One student who had practiced was from the class of December '82 and had, therefore, been initially certified eighteen months ago.

TABLE XIII

CPR Skill Performance Following Practice

	% Pass Student #1 - Dec. 82	% Pass Student #2 - Apr. 83
Overall Skill Performance		
one man CPR	0%	0%
two man CPR	0%	0%
Discrete Aspects of CPR		
shake and shout	100%	100%
look, listen and feel	100%	100%
initial four ventilations	0%	0%
checking carotid pulse	100%	100%
calling for help	100%	100%
hand position	100%	100%
one minute pulse	100%	0%
initiation of two man CPR	0%	100%
two man switchover timing	0%	0%
initial assessment	100%	100%
initial pulse check	0%	100%
one minute pulse check	0%	0%
one man CPR	0%	0%
two man CPR	100%	0%
Continuous Aspects of CPR		
ventilation depth	0%	0%
compression depth	100%	0%
compression continuity	0%	100%
one man sequence	0%	0%
two man sequence	100%	100%

This student had practiced CPR on a manniken five times in eighteen months. This student failed both one and two man CPR overall.

The discrete aspects of the CPR performance were not performed consistently well. Only three initial ventilations were given instead of four. The rate of compression was changed before the second rescuer gave the first breath in the initiation of two man CPR and the student changed too soon once the switchover was called for. The initial pulse check and the one minute pulse check were completed too quickly and timing for one man CPR overall was far too slow (99 seconds). Shake and shout; look, listen and feel; checking the carotid pulse; calling for help; hand position; one minute pulse check; timing for the initial assessment; and timing of two man CPR were performed adequately according to Canadian Heart Foundation criteria.

The continuous aspects of the CPR performance were performed inconsistently as well. Ventilations for both one and two man CPR were too heavy and the student did not remove her weight from the manniken completely between compressions. This student also completed the one man sequence with cycles of thirty, fifteen, twenty and then fifteen compressions to two ventilations. The depth of compressions was adequate as was the sequence of two man CPR.

The only other student who had practiced was from the class of April '83 and had been certified initially twelve months ago. This student had performed CPR on a victim once. In the retesting she also failed both one and two man CPR overall.

The discrete aspects of CPR were performed correctly in all areas except the following: only three initial ventilations, failure

to do the one minute pulse check, and no performance of the two man switchover. One and two man CPR were both performed too quickly.

This student performed inconsistently on the continuous aspects of CPR as well. Compression continuity and the two man sequence were performed according to Canadian Heart Foundation standards. However, ventilations were adequate for one man CPR but too shallow for two man. Compressions were also adequate for one man but too light for two man CPR. The sequence for one man CPR consisted of five compressions only per cycle.

Results indicate, therefore, that the practice which these two students had in the interval between initial certification and the retesting session did not seem to enhance their recall of the skill of CPR in the retesting session.

CHAPTER V

Summary, Conclusions and Recommendations

This final chapter contains a summary of the study, the conclusions derived from the study, and recommendations for further research.

Summary

There is very little research available dealing with the retention of CPR skills. Even less research exists dealing with the aspect of recertification.

The purpose of this study was to examine the extent to which people retain CPR skills over time in order to determine if and when it is necessary to reteach or recertify. The study dealt specifically with overall CPR performance on one and two man CPR, retention of the discrete and continuous aspects of CPR performance, and whether practice on a manniken or victim enhanced the CPR performance during the retesting session.

A review of the education and nursing literature provided information on motor skill acquisition and retention. Further research into the nursing and medical literature provided information on CPR itself and studies related to the retention of this complex motor skill. These studies were conducted from three months to eighteen months after initial CPR certification. Of those which tested persons less than one year after initial certification, all found that recall was generally poor even three months after initial certification. Four studies recommended recertification with two recommending recertification every

six months, one once yearly and one stating only that once yearly recertification is not enough. Discrete aspects of CPR were found to be recalled more poorly than the continuous ones.

This study consisted of practical testing of the skill of CPR with students from the University of Alberta Hospitals School of Nursing who had initially been certified six, ten, twelve and eighteen months previously.

Results of these practical tests were then analyzed according to overall skill performance, continuous and discrete skill performance, and whether practice enhanced the retesting session.

The results of the analysis showed that:

1. no student in any class performed both one and two man CPR according to Canadian Heart Foundation standards.

2. only one student performed one man CPR at or above Canadian Heart Foundation standards. This student had initially been certified ten months ago.

3. only one student passed two man CPR. She had taken her initial course twelve months ago.

4. discrete skills were generally performed quite poorly with shake and shout being the only aspect performed perfectly by all students.

5. continuous skills were performed to a higher degree than discrete skills overall. Students, however, performed quite poorly on compression and ventilation depths.

6. students who had practiced CPR either on a manniken or a victim since initial certification did not perform at or above Canadian Heart Foundation standards on the overall performance for one and two

man CPR, the discrete aspects, or the continuous aspects of the performance.

Conclusions

The conclusions which can be derived from this study are that:

1. students who have initially been certified in CPR six, ten, twelve and eighteen months ago are not able to perform one and two man CPR at or above Canadian Heart Foundation standards. Therefore, persons should be recertified in CPR at least every six months to ensure that the skill is being performed at or above Canadian Heart Foundation standards.

2. the discrete skills of CPR, since they are generally performed poorly, should become more of a focus in CPR courses. For example, if a student makes an error while practicing CPR during a course, the student should start the CPR performance over from the beginning to allow for more repetition of the discrete aspects of the skill.

3. because the continuous skills are repeated many times during the performance, they are performed with more accuracy than the discrete skills. However, these skills are still not performed at or above Canadian Heart Foundation standards.

4. CPR practice does not guarantee improved skill performance. Supervised practice with a CPR instructor may however change this as assurances could be made that students were not practicing mistakes to perfection.

5. CPR recertification should be reinstituted and be made mandatory at least every six months after initial certification.

6. educational administrators, who are involved in decision making related to the planning for and implementation of CPR courses and recertification sessions, now have data related to the retention of CPR and, based on the data, a recommendation for recertification at least every six months to aid their decision making.

7. in accordance with other CPR retention studies, CPR skills are not retained for long periods of time and, therefore, recertification must be carried out. In the studies where recertification is addressed the recommendations have been similar, ranging from once yearly (one study) to every six months (four studies) following the initial CPR course. Therefore, this study supports the findings of the majority of CPR skill retention studies.

8. in contrast to other motor skills described in Chapter 2, the skills of CPR is retained for a short period of time (six months versus twelve to twenty-four months). This short retention period is due to the fact that CPR is a relatively complex skill comprised of both discrete and continuos skills.

Recommendations

The following research could augment the findings of this study:

1. additional research with other groups who have completed initial certification over varying time intervals to determine overall CPR retention and retention of the continuous and discrete aspects of the CPR performance. Recommendations for recertification should also be included.

2. retention studies comparing groups which have had scheduled physical and/or mental practice prior to retesting to groups having no practice prior to the retesting.

3. research investigating the utilization of computers to assist with the teaching of CPR courses, the running of practice sessions following initial certification, and recertification.

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Appendix 1

QUESTIONNAIRE A

Retention of Cardiopulmonary Resuscitation Skills

In the box provided, please indicate the letter which represents the most accurate completion of each statement.

1. Time of initial CPR certification:

   a) before entering the School of Nursing

   b) after entering the School of Nursing

2. Highest level of CPR certification:

   a) basic rescuer

   b) instructor

   c) instructor-trainer

CONSENT FORM

I,_____, student nurse at the University of Alberta Hospitals School of Nursing, grant permission to Debbie Poeter, graduate student at the University of Alberta, to test me on one and two man cardiopulmonary resusitation utilizing the recording Resusi-Anne manniken to determine my retention of CPR skills.

I understand that I will be tested according to Canadian Heart Foundation criteria. I understand further that neither my name nor any identifying information about myself or my performance will be presented in the thesis, and that my performance will not, in any way, be considered in relation to my future performance within the School of Nursing. I also understand that I may withdraw from the study at any time without fear of penalty to myself.

Signature_____ Date_____

Witness_____

QUESTIONNAIRE B

Retention of Cardiopulmonary Resuscitation Skills

In the box provided, please indicate the letter which represents the most accurate completion of each statement.

1. Practice of cardiopulmonary resuscitation skills since initial certification:

   a) no.

   b) yes. Please specify how many times _____. ☐

2. Use of cardiopulmonary resuscitation on a victim in an emergency situation since initial certification:

   a) no.

   b) yes. Please specify how many times _____. ☐

Appendix 2

CANADIAN HEART FOUNDATION

BASIC LIFE SUPPORT

CARDIOPULMONARY RESUSCITATION PERFORMANCE TEST FOR ONE AND TWO RESCUER CPR

Name: _____ Date: _____

ELAPSED TIME (seconds) min.	max.	ACTIVITIES AND TIME (Seconds)	CRITICAL PERFORMANCE	PASS	FAIL
6	10	Establish unresponsiveness and call out for help. Allow 6-10 sec. if face down and turning is required. Open Airway.	Shake shoulder, shout - "Are you OK?". Call for HELP. Turn if necessary. Adequate time.		
10	15	Establish breathlessness. (Look, Listen, and Feel). (4 sec. - 5 sec.)	Kneels properly. Heal tilt with one hand on forehead and neck lift or chin lift with other hand. Ear over mouth, observe chest.		
13	20	Four Ventilations. (3 - 5 sec.)	Ventilate properly 4 times and observed chest rise.		
20	30	Establish pulse and stimulate activaton of EMS system (7 - 10 sec.)	Fingers palpate for carotid pulse on near side (other hand on forehead maintains head tilt). Know local emergency number. Adequate time.		
74	96	Four cycles of 15 compressions 2 ventilations (54 - 66 sec.)	Proper body position. Landmark check each time. Position of hands. Vertical compression. Says mnemonic. Proper rate. Proper ratio No bouncing. Ventilates properly.		
81	106	Check for return of pulse and spontaneous breathing. (7 - 10 sec.) (Pupil check optional)	Check pulse and breathing (Pupil check optional.		
97	126	Minimum of four cycles of 5 compressions and 1 ventilation (16 - 20 sec.) Switch and repeat until examiner is satisfied.	Changes rate of compression. Says mnemonic. Interposes breath. No pause for ventilation. Call for switch. Change after three next time. Switches. Switches back. Checks pulse (by ventilator) (Pupil check - optional). Techniques as above.		

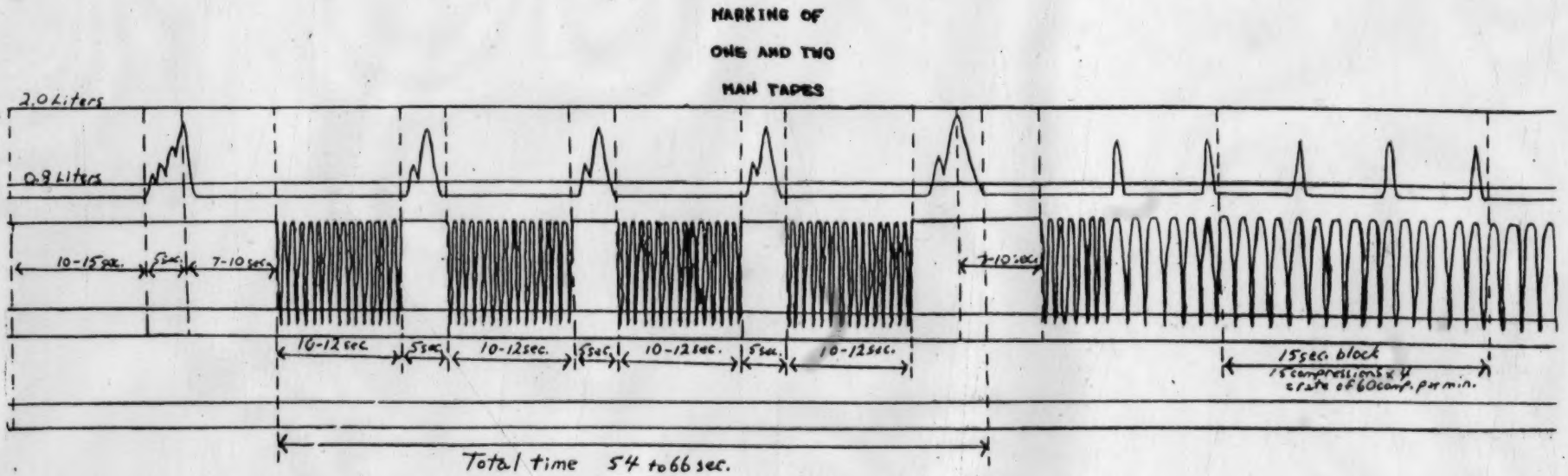
For single rescue - Number of compressions 60 Number of ventilations 12

INSTRUCTOR: _____ Single Rescuer Technique (Check) PASS ___ FAIL ___

Two Resuer Technique (Check) PASS ___ FAIL ___

Revised from the American Heart Association Manual 1977.
BLS. - 1 & W - 1/78 - 10M. REV.

Appendix 3



From: The American Heart Association Manual for Instructors of Basic Cardiac Life Support, 1980.